November 1968

Final Report

EVALUATION OF CIVIL DEFENSE OPERATIONAL CONCEPTS

By: RICHARD LAURINO C. ALEXANDER KAMRADT

Prepared for:

OFFICE OF CIVIL DEFENSE
OFFICE OF THE SECRETARY OF THE ARMY
WASHINGTON, D.C. 20310

CONTRACT NO. DAHC-20-67-C-0116
OCD WORK UNIT 2611D

S R I Project MU-6250-020

This report has been reviewed in the Office of Civil Defense and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Office of Civil Defense.

STANFORD RESEARCH INSTITUTE

MENLO PARK, CALIFORNIA

51

STANFORD RESEARCH INSTITUTE
Menlo Park, California 94025 · U.S.A.

November 1968

Final Report

EVALUATION OF CIVIL DEFENSE OPERATIONAL CONCEPTS

By: RICHARD LAURINO C. ALEXANDER KAMRADT

Prepared for:

OFFICE OF CIVIL DEFENSE
OFFICE OF THE SECRETARY OF THE ARMY
WASHINGTON, D.C. 20310

CONTRACT NO. DAHC-20-67-C-0116
OCD WORK UNIT 2611D

S R I Project MU-6250-020

SUMMARY

In reviewing the recently developed operational concepts given in the Federal Civil Defense Guide for adequacy, the requirement to distinguish between fire effects and fallout effects in civil defense operating situations is clearly indicated. A review of the operational factors also verifies a requirement for distinguishing between at least three levels of hazard for both fire and fallout effects. The resulting nine BOS (basic operating situations) appear to be the minimum required number for command use. The five operational plans associated with the nine basic operating situations provide the minimum number of plans consistent with local civil defense operations.

The emergency operational plans given in the Federal Civil Defense Guide cover the most basic points needed to develop plans for operating zones and communities. Additional guidance would be required to cover the interdependence of the operating zones. For instance, operational plans should contain more instructions on how to handle refugees moving from one zone into another.

The use of BOS data for NUDET purposes appears to be feasible. However, the determination of weapon damage radius based on fire damage alone appears to be inadequate. Additional reports on blast damage conditions would increase the value of BOS data for NUDET purposes.

The Federal Civil Defense Guide suggests that operating zones be small in area relative to the scale of weapon effects. Such a condition would allow for one BOS condition to be associated with each operating zone, thereby simplifying the operating procedures. This study determined that for megaton yields the change in fallout radiation over operating zones of area less than 25 square miles would be sufficiently small to permit a single BOS condition. The probability of observing differences in dose rates of more than a factor of 40 was shown to be very small, based on U.S. wind frequency data. Blast effects showed a great range of variation over one operating zone.

A preliminary investigation was made of the relationship between civil defense and ballistic missile defense command and control. While national command and control has an important role to play in the post-attack period, the nature of civil defense operations requires local independent command. Possible future civil defense developments might make possible coordination of civil defense and ballistic missile defense tactics.

STANFORD RESEARCH INSTITUTE
MENLO PARK, CALIFORNIA

November 1968

Final Report

EVALUATION OF CIVIL DEFENSE OPERATIONAL CONCEPTS

By: RICHARD LAURINO C. ALEXANDER KAMRADT

Prepared for:

OFFICE OF CIVIL DEFENSE
OFFICE OF THE SECRETARY OF THE ARMY
WASHINGTON, D.C. 20310

CONTRACT NO. DAHC-20-67-C-0116
OCD WORK UNIT 2611D

S R I Project MU-6250-020

ABSTRACT

The concepts of civil defense operational planning for the trans-attack period on the basis of expected operational situations or contingencies are reviewed. Nine situations based on combinations of selected levels of fallout intensities and weapon-caused fires are considered, including one situation entailing no weapons effects. The required emergency operations attendant to each situation are identified. The geographical area for which operational contingency plans would be developed would be such that the operational situat . ..ould be the same throughout the area. Accordingly, statistical measures were developed as the basis for selection of the unit areas that show the fallout intensity gradients as a function of a range of weapon yields and probable wind conditions, expected thermal ignition ranges, and overpressure scaling functions.

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS

I INTRODUCTION

Objectives

Evaluation of civil defense countermeasures depends heavily on the ways in which the overall civil defense operation is to be performed. Such evaluations have been hampered by the lack of a unified, up-to-date body of operational concepts relating to civil defense operations in nuclear war.

Such a body of knowledge must be expected to evolve over time. At the present time, accumulated knowledge of civil defense problems has made it possible to improve on the civil defense concepts and doctrines. The work presented in this report evolved largely during the preparation of the current Federal Guide.* The basic purpose of the research was to review past and present operational concepts in the light of emerging threats and strategic environments and to aid in the modification and testing of concepts.

Specific tasks as provided in the statement of work included:

1. A critique of current concepts and doctrine with respect to the developing threat and the increasing number of strategies for its application.

2. Development of operational concepts and doctrine to meet future threats and strategic environments.

3. Expansion of concepts and doctrine to reflect increasing capability of civil defense.

4. Consideration of modifications of concepts and doctrine in the presence of active defense systems.

Early Civil Defense Concepts

With the beginning of the nuclear era, it became clear that civil defense units, regardless of training, equipment, and organization, would be overtaxed during the initial postattack periods. Therefore, a requirement existed for maximum use of all available resources in a locality and

---

* "Concept of Operations Under Nuclear Attack," Federal Civil Defense Guide, Part G, Chapter 1, Appendix 1, Office of Civil Defense, November 20, 1967.

for selective use of these resources in places where the most good could be done. This requirement led to the development of a number of fundamental concepts. Many civil defense units were considered cadre units that could be expanded with volunteers during the time of need. The necessity for self-help among survivors was stressed.

The suddenness and magnitude of the damage made it necessary to consider that civil defense units would operate independently for a period of time immediately following the attack. The requirement for help from outside the affected area to support local forces was recognized.

An examination of the weapons effects in relation to civil defense operations revealed that: (1) certain areas would be so severely damaged that no immediate civil defense operations could be undertaken profitably, (2) other areas essentially would be undamaged and would be able to assist damaged areas, and (3) still other areas would exhibit light to moderate damage and should receive the principal civil defense effort.

The investigation of coordinated actions of civil defense operations resulted in the concept of a perimeter defense. An interior perimeter appeared desirable to surround areas of heavy blast and fire damage. This fire perimeter, or obstruction perimeter, was to define areas where continued survival was not likely and to prevent firespread to areas less heavily damaged. At greater distances where light blast damage was observed, another line called a support perimeter appeared desirable. This perimeter was to represent the control border of the area under civil defense authority. The major support groups and refugee control centers were to be located in the vicinity of this line and along major transportation routes.*

The civil defense objectives in postattack recovery have a change in emphasis from the time of the attack. In the initial period, called the emergency phase, the objective was to contain the damaging effects and to provide for immediate survival of the population. After these conditions had stabilized, civil defense efforts would be directed toward restoration of essential functions (the initial recovery phase). Later, efforts would be directed toward restoring full economic capabilities to the area, i.e., final recovery phase. A more recent representation includes four phases in which the final recovery phase is divided into two parts, a reconstruction phase for recovery of the economy and a final recovery phase--an indefinite period to minimize the long term nuclear effects. A readiness phase also has been explicitly recognized to account for actions taken before the warning of the attack.

---

* Much of this early work is discussed in Radiological Defense, Volume II, produced at NRDL for AFSWAP. Some of the unpublished material from this early effort recently was incorporated into a Dikewood report.

Determinants of Civil Defense Concepts

Four basic elements should influence the civil defense doctrine: (1) the characteristics of the weapon effects, (2) the characteristics of the target, (3) consideration of the time intervals with respect to the attack, and (4) the basic structure and status of the organization. A civil defense doctrine must take into account all the various hazards related to nuclear weapons effects, such as fire, fallout radiation, blast, and a combination of these effects. Civil defense concepts should be influenced by the magnitude of the effects associated with modern weapons (megaton yields, large numbers of weapons, and so on). The doctrine must recognize that civil defense organizations may experience varying degrees of involvement in a nuclear event, that is, they may be faced with severe damage, moderate damage, or, possibly, no damage at all.

Civil defense doctrine should remain flexible but should also consider to a reasonable degree the characteristics of the target area where civil defense operations are to be performed. The degree of complexity of civil defense operations must be expected to vary not only with the effects but also with the character of the metropolitan areas. The civil defense doctrine also must recognize that the target characteristics can change depending on the strategic situation that exists before the attack. Consequently, the vulnerability and resources associated with any given area in the city could vary widely.

Some of the major target features include:

1. Building characteristics (vulnerability, shelter, and such)
2. Built-upness, e.g., downtown areas, industrial areas, large open areas
3. Major transportation routes
4. Major resources, e.g., utilities, industrial, military
5. Population and CD readiness and deployment

The development of a clear and complete set of concepts also requires recognition of the fact that the centers of action and decision in the civil defense organization change over time. For instance, immediately after an attack, most of the decisions that can be implemented immediately would be those made by the individual or by the shelter leader. Certain actions such as putting out fires and rendering first aid should be automatic. At a short time thereafter, the focus of decision moves to the local CD units where immediately available forces can be brought into action to support the population in the area.

With time, the center of decision moves to the EOC (Emergency Operations Center), and this might be a matter of hours rather than minutes. At this time, the civil defense operation presumably would become

somewhat better structured, and it is possible to consider implementing concepts such as defense perimeters. At still later times (and here time might be measured in terms of days or weeks), state and regional authorities would be the center of the decision-making process. Basically, then, the civil defense decision-making process can be considered as evolving over time and moving upward in the organizational structure. The consideration of this evolution avoids possible contradictions between organizational levels and defense concepts that really would occur at different stages in the development of the total civil defense operation.

II SUMMARY

In reviewing the recently developed operational concepts given in the Federal Civil Defense Guide for adequacy, the requirement to distinguish between fire effects and fallout effects in civil defense operating situations is clearly indicated. A review of the operational factors also verifies a requirement for distinguishing between at least three levels of hazard for both fire and fallout effects. The resulting nine BOS (basic operating situations) appear to be the minimum required number for command use. The five operational plans associated with the nine basic operating situations provide the minimum number of plans consistent with local civil defense operations.

The emergency operational plans given in the Federal Civil Defense Guide cover the most basic points needed to develop plans for operating zones and communities. Additional guidance would be required to cover the interdependence of the operating zones. For instance, operational plans should contain more instructions on how to handle refugees moving from one zone into another.

The use of BOS data for NUDET purposes appears to be feasible. However, the determination of weapon damage radius based on fire damage alone appears to be inadequate. Additional reports on blast damage conditions would increase the value of BOS data for NUDET purposes.

The Federal Civil Defense Guide suggests that operating zones be small in area relative to the scale of weapon effects. Such a condition would allow for one BOS condition to be associated with each operating zone, thereby simplifying the operating procedures. This study determined that for megaton yields the change in fallout radiation over operating zones of area less than 25 square miles would be sufficiently small to permit a single BOS condition. The probability of observing differences in dose rates of more than a factor of 40 was shown to be very small, based on U.S. wind frequency data. Blast effects showed a great range of variation over one operating zone.

A preliminary investigation was made of the relationship between civil defense and ballistic missile defense command and control. While national command and control has an important role to play in the post-attack period, the nature of civil defense operations requires local independent command. Possible future civil defense developments might make possible coordination of civil defense and ballistic missile defense tactics.

III CRITIQUE OF OPERATIONAL CONCEPTS

Basic Operating Situations (BOS)

An unlimited number of BOS (basic operating situations) could be specified. Because of the limited number of alternative actions available to the civil defense organization and other difficulties of building unlimited flexibility of response into any large organization, it is desirable to limit the number of recognized operational situations to a minimum. The earliest actions in the transattack and postattack periods are designed against continuing hazards. The two principal hazards in the early time period are fire and fallout. In the recent FCDG section, Concept of Operations Under Nuclear Attack, three fallout conditions and three fire conditions were specified. OCD proposes a combination of these levels of hazard in the nine basic operating conditions (see Figure 1). The number of conditions needed has been reduced by combining considerations of physical damage with civil defense capability to response to this damage; hence, fire is divided into controllable and uncontrollable levels and subsumes all the problems of blast damage within the fire designations. This procedure would appear justified in an operating zone, since the main reason for specifying a BOS is to decide on how to respond to the hazards. On the other hand, combining hazard level and operational capacity into one BOS would reduce the information delivered to the next higher level of command.

Criteria for Defining BOS Thresholds

The threshold conditions between one BOS level and another are recognized by means of sample measurements and direct observations. For fallout conditions, dose rate values are specified (0.5 r/hr and 50 r/hr). The actual values are somewhat arbitrary but do show a range of radiation levels that represent essentially the same hazard to persons engaged in emergency operations. Below 0.5 r/hr, emergency operations could be performed with essentially no concern for the radiation field. Between 0.5 and 50 r/hr substantial doses could be received within a short period (as few as 4 hours) that could cause injury to unshielded personnel; therefore, radiation would be a factor in carrying out operations. Above 50 r/hr, the time available for unshielded operations drops to a value that makes effective action outside generally unfeasible. The wide spread between upper and lower thresholds makes possible common operations over a relatively large area; problems of measurement also are largely overcome by a wide spread of threshold values.

Errors in reading meters of a factor of 2 or more would not be uncommon. Earlier work indicates that differences in the threshold values

FIG. 1 NINE BASIC OPERATING SITUATIONS

	NEGLIGIBLE FIRE	CONTROLLABLE FIRE	UNCONTROL-LABLE FIRE
NEGLIGIBLE FALLOUT	1 NEGRAD NEGFIRE	4 NEGRAD LOFIRE	7 NEGRAD HIFIRE
MODERATE FALLOUT	2 LORAD NEGFIRE	5 LORAD LOFIRE	8 LORAD HIFIRE
SEVERE FALLOUT	3 HIRAD NEGFIRE	6 HIRAD LOFIRE	9 HIRAD HIFIRE

of about 10 should be adequate to cover errors in measurement.* Also, the operating zone controller would have at the most a few measurements to represent conditions over the entire zone. Errors that result from an insufficient number of readings over an area make desirable a spread of another factor of 20 to 40. In general, the factor of 100 difference in the threshold values appears to be adequate for a great range of operational situations.

The definition of fire thresholds differs from that of radiation since no completely objective means of measurement is provided. Also, the fire threshold implies not only physical damage but also operational capability. That is, the conditions specified depend on the controller's judgment concerning the ability of local forces to control incipient fires. The decision might be based on a prediction of the future course of events rather than on a statement of the present physical condition. This definition is adequate for immediate operations in the zone, since the judgment of the operating zone controller would determine what countermeasure action should be taken immediately. This information would also aid the EOC, but it does not indicate clearly the nature of the physical conditions in that zone. Consequently, as the total civil defense operation becomes better organized and control of CD units passes up the organizational chain, the EOC would require additional information on many of the operating zones. Initial reporting of the operating zones would also be helpful to the EOC in making selective inquiries for such additional information.

Other Possible BOS Conditions

The utility of the nine BOS conditions† can be appraised by comparing these conditions with other possible combinations. From the point of view of local operations, it would be desirable to have less than nine conditions. Higher command might want more.

The definition of BOS conditions results from considerations of (1) the qualitative distinctions related to type of hazard, i.e., fire or fallout, and (2) quantitative distinctions related to the degree of involvement (0.5 r/hr or 50 r/hr, and such). A reduction in the number of BOS states could not be obtained realistically by eliminating one of the two qualitative distinctions, fire or fallout, without totally distorting the reaction of the civil defense organization to the environment. Also, no fewer than three levels of involvement for each type of hazard would be realistic. Since operations in a nuclear environment should be based on selective action in moderately damaged areas making use of support from undamaged areas, a distinction among undamaged, moderately damaged, and severely damaged is essential. The three levels in involvement and the two hazards result in a minimum of nine BOS conditions.

---

* See Richard B. Bothun and Richard K. Laurino, Radiological Monitoring Concepts and Systems, Stanford Research Institute, February 1963.

† FCDG, ibid.

Some of these conditions might be combined in an operational sense, e.g., LORAD-LOFIRE and NEGRAD-LOFIRE might call for the same operational response. However, since the operating zone controller must assess fallout and fire hazards independently, he would go through the mental process of combining the conditions in any event. Thus, regardless of the operational similarity of some of the conditions, the nine BOS conditions would be a necessary by-product of the decision process at the operating zone and should be useful at higher levels of command.

A substantially larger number of BOS conditions could be postulated and would have some merit for use by higher levels of command. At least five qualitative distinctions can be identified. They are: (1) fallout only, (2) fire only, (3) a combination of blast and fire, (4) a combination of fallout and fire, and (5) a combination of blast damage, fallout, and fire.

An earlier SRI report identified five levels of involvement for radiation hazards.* These are: (1) peacetime (hazard levels in accordance with existing peacetime regulations), (2) normal (above peacetime hazard levels but requiring no modification of emergency operations), (3) noncritical (hazards sufficiently large to require controlled operations), (4) critical (hazards sufficient to cause fatalities unless operations are severely limited), and (5) extreme (conditions under which operations are completely prohibited). The combination of these qualitative and quantitative distinctions would result in 105 conditions. This number certainly is too large for the operational organization in an emergency. However, the question remains as to how far the number can be cut back without significantly affecting operations.

The number of conditions has been reduced by combining blast and fire effects. The validity of combining these effects depends on how the loss of information or capability would affect countermeasure actions. To understand this point, it is necessary to review how blast effects add to the problem. The more important effects are:

1. Significantly increased casualties

2. Damaged buildings, trapped people, and reduced effectiveness of shelters

3. Debris that hampers movement

4. Damaged utilities

5. Reduced capability of local forces

6. Additional fires.

---

* Bothun, op cit.

Also to be considered is what, in theory, an operation zone controller would do in a mixed blast-and-fire situation. The more important possibilities would include:

1. Employing medical care for casualties

2. Sending rescue teams to free trapped persons

3. Sending engineering teams to clear streets of debris

4. Employing teams to make emergency repairs of utilities

5. Calling up additional forces from other zones

6. Fighting fires and/or evacuating.

In civil defense as it is currently known, first aid is the only kind of medical care that can be given immediately. This action should be part of the immediate reaction of the people regardless of the BOS condition established. Engineering rescue to free trapped people always has been recognized to be of limited value in blast-damaged areas because of the immensity of the problem compared with the available time and personnel. Guide rescue, i.e., the direction of people from damaged areas to relatively undamaged areas, is generally desirable and feasible in either a fire or a mixed blast-fire environment. Clearing streets of debris in the emergency phase is also recognized as unfeasible in the early times because of time and personnel limitations. Provision of emergency utilities would likely lie outside the capability of an individual operating zone controller and would depend on actions at EOC level or higher. Additional rescue forces would be provided on the judgment of the EOC and would require hours to become effective. Thus, the fighting of fires and the possibility of evacuation remain principal tools at the disposal of the operating zone commander.

It becomes evident that, in today's civil defense, most of the types of countermeasures that would be peculiarly suitable to a blast-damaged area are not and would not be available to local civil defense in time to affect the outcome. The things that can be done, i.e., first aid, guide rescue, fighting of fires, and general evacuation, are common to both fire-only situations and blast-and-fire situations. The combination of fire and fallout conditions would not affect the kinds of measures that would be implemented but would affect to some degree the ability of the local units to carry out these measures.

The combination of blast and fire thus appears justified for the sake of simple doctrine. However, the existence of substantial blast damage in the fire environment will reduce the capability of the operating zone controller to carry out his objectives. This fact should be reflected in the detailed planning of each zone.

The value of specific blast information is likely to be more significant to the EOC. Blast information would provide a much better

indication than fire information of the location of a burst. The kind and severity of damage would be helpful to the EOC in allocating reserve forces (medical, fire, and so on). Blast damage information would alert the EOC concerning the requirement for, and the likely nature of, damage control for utility systems (where to shut off the water mains, and such). In terms of the developing civil defense effort, early information on blast damage would assist in the initial selection of the obstruction perimeters and the support perimeters and would assist in the vectoring of incoming emergency forces. Early information on blast would also be helpful in warning other operating zones concerning the load of refugees requiring medical assistance and would help the EOC to decide on the re-allocation of mobile forces initially assigned to operating zones.

Part of the information relating to blast will come to the EOC from other sources; for instance, the arrival of large numbers of refugees with blast injuries at a hospital in an adjacent operating zone will be clear evidence of blast damage. Also, some of the information will be needed at somewhat later times, that is, hours rather than minutes. For instance, the obstruction perimeters and support perimeters probably will not be established for hours after the attack. However, the advantages to be gained from early control of damaged utilities and the allocation of medical facilities may be sufficient to warrant reporting specific blast damage immediately to the EOC. It is also suggested that perhaps some planning should be done by each operating zone to support other operating zones, either by receiving refugees or moving mobile forces into an adjacent zone.

Countermeasures and Plans Related to BOS

A limited number of countermeasures are available to local civil defense shortly after an attack. These countermeasures are various forms of the following actions:

1. Taking shelter
2. Fighting fires
3. Medical and refugee welfare
4. Evacuation
5. Limited rescue (guide rescue)
6. Law enforcement.

These countermeasures are to be combined in emergency operational plans that are suitable for various BOS conditions. The "concepts" section of FCDG suggests five operational plans to cover the nine BOS conditions (see Figure 2). These plans are expected to be made for each

FIG. 2 LOCAL CONTINGENCY PLANS

CONTINGENCY	BASIC OPERATING SITUATION	SITUATION DEFINITION	PRIORITY ACTIONS
FREE	NEGRAD-NEGFIRE	No weapon-caused fires; dose rate less than 0.5 R/hr.	Maintain initial shelter posture; provide aid to other zones as feasible; prepare for reception of survivors.
MODERATE FALLOUT	LORAD-NEGFIRE	No weapon-caused fires; dose rate between 0.5 and 50 R/hr.	Protect population in shelter; conduct dose limited essential operations; provide aid to other zones as feasible.
SEVERE FALLOUT	HIRAD-NEGFIRE	No weapon-caused fires; dose rate above 50 R/hr.	Make maximum use of available shelter; conserve shelter resources; minimize outside operations.
CONTROL-LABLE FIRES	NEGRAD-LOFIRE LORAD-LOFIRE HIRAD-LOFIRE	Scattered fires subject to potential control; radiation hazard may exist or be imminent.	Conduct emergency operations to control or suppress fires; treat injured; maintain population in shelter.
UNCONTROL-LABLE FIRES	NEGRAD-HIFIRE LORAD-HIFIRE HIRAD-HIFIRE	Many fires beyond control capability; radiation hazard may exist or be imminent.	Relocate and protect threatened shelter groups as feasible against fire and fallout threats.

operating force, since, at least initially, an operating zone might have to function in isolation.

The fact that initial actions in an operating zone might be taken in isolation does not mean that plans should be made in isolation. Each operating zone plan must take into account the fact that conditions originating outside a zone could have an impact quickly on conditions inside the zone. For instance, refugees will probably be crossing from one zone to another, regardless of the BOS conditions or operational plans.

The requirement to aid the injured and refugees is clearly reflected in guidance for operational plans relating to "free" and "moderate fallout" conditions. While movement to shelter of the population is suggested, aid to refugees and mutual aid to damaged operating zones are to be part of the plans. Some future guidance appears to be desirable to describe how aid is to be delivered when the population (and the CD force) is in shelters. Perhaps aid could be provided by CD workers remaining outside, possibly with the aid of a portion of the population recruited from the larger shelters. Certainly, for these BOS conditions, aid should take precedence over taking shelter. The question also arises of what could be done to protect refugees, for instance, if the refugees should stay outside while most of the population remains in shelters. Unless questions of this kind are addressed in the operational plans, these plans will require modification shortly after they are implemented.*

The guidance for other BOS conditions does not recognize the necessity of providing for problems originating outside the zone. Populations from a zone with HIRAD-HIFIRE might evacuate to a zone with HIRAD-LOFIRE or HIRAD-NEGFIRE BOS states. In these other zones, the population and CD force would be making maximum use of shelter. The conditions would require the CD force of the recipient zone either to help control refugees or to pass responsibility on to the CD force of the evacuating zone. In civil defense as it will probably exist in the near future, CD forces of both zones might have to be used in controlling refugees regardless of the radiation or fire level.

While the study of this difficult problem could well be the subject of a separate research task, certain fundamental considerations are evident. The objectives of a recipient zone (in any BOS state) would be to render assistance to refugees without endangering the protective status of the host population. If an operating zone is in a low hazard condition, i.e., LORAD LOFIRE or lower, it could act as a "terminal" zone and provide interim aid and welfare to the refugees. If the recipient zone is in a higher hazard state, then it should be an "intermediate" zone and should direct refugees toward a terminal zone. An intermediate zone could, where possible, offer protection to refugees up to the point where

---

* Section V of the FCDG "Concept of Operations" recognizes the requirement to vary from basic plans.

the protection of the host population was endangered. The EOC would be responsible for informing an operating zone of conditions in surrounding zones and for suggesting evacuation routes.

The problems associated with higher hazards to both fire and fallout always have been difficult to meet with available civil defense measures. Loss of life under such conditions would often be heavy. However, the basic approach of giving priority to fighting fires should enhance chances of survival. The examples provided in the FCDG "Concepts" demonstrate how quickly fire could get out of control (10 to 20 minutes). Since fallout arrival might well require the longer period, the issue of controlling fires might generally be decided before fallout arrival. In some areas, fallout might well precede the fire, e.g., fallout bursts on military targets hours before bursts on cities.

Problems would arise in trying to respond to the fire problem if an operating zone were already in a "Rad" condition. Since the population would presumably be in the best available shelter in selected structures, most buildings would be unoccupied at the time ignitions occurred. It is unlikely that the civil defense organization could respond quickly enough under these conditions to prevent a LOFIRE condition from becoming a HIFIRE condition. Provisions therefore would be required in the basic plan to anticipate thermal effects.

Thermal ignitions also produce problems deserving study in depth. The principal requirements would be: (1) to have people on hand to fight fires when they occur and (2) to intensify thermal protective measures before moving to fallout shelter.

In anticipation of fires, it would appear desirable to leave fire guards in most structures in all "Rad" conditions. While most structures are not selected as CSP (Community Shelter Plan) shelter locations, these buildings generally could provide adequate shelter for a few people. Such shelter either exists (in machinery rooms, staircases, and such) or can be provided by emergency techniques, e.g., "knockdown" citadel shelters. Provision of emergency shielding in non-CSP buildings should be part of the plan for all "Rad" BOS states. If thermal ignitions occurred, guards could then move through the interior of the structure, eliminating fires during the first 10 to 20 minutes. This action could be undertaken in regions where the free field radiation levels range from 1,000 to 3,000 r/hr without significant loss of life.

Chances of controlling fires would be greatly enhanced if thermal protective measures were intensified before moving the population to shelter. Often advance warning of possible fallout would be received from EOCs and would provide time for thermal countermeasures such as covering windows and removing flammables from direct line of windows. Fireguards could continually upgrade thermal protection after the rest of the population had been withdrawn and before fallout arrival. This latter action would depend on additional procedures for warning fireguards of the onset of fallout.

The operational plan for "uncontrollable fire" includes three BOS conditions, i.e., NEGRAD-HIFIRE, LORAD-HIFIRE, and HIRAD-HIFIRE. There is little question that one operational plan should cover the requirement of the NEGRAD and LORAD conditions, since fire would be essentially the only casualty producer. In the HIRAD condition, casualties could be expected from both radiation and fire.

The general strategy of operations in a HIRAD-HIFIRE zone would be to move people out of immediate fire danger while minimizing exposure to radiation. This might be accomplished by: (1) delaying movement to take advantage of radiation decay and (2) minimizing the time that evacuees spend outside shelter. HIFIRE areas with sufficient building density to make evacuation impossible during the full development of the fire, i.e., mass fire entrapment areas, would have to be evacuated as quickly as possible. Since most areas are not of this density, some delay in evacuation might be possible. Other areas would reach the HIFIRE condition because of firespread. In these instances, the rate of spread of the fire would likely be slow compared with the possible rate of evacuation. Historical evidence indicates that firefront generally moves at less than a block an hour except for firebrand "spotting" downwind of the firefront. This fact would allow slow withdrawal of population crosswind on a block-by-block basis. The fire-spotting problem would dictate another requirement for fireguards in LOFIRE and NEGFIRE zones downwind of a mass fire.

BOS Conditions as NUDET Information

The FCDG "Concepts" section suggests the use of BOS reports as a source of nuclear detonation (NUDET) information. Information that might be obtained includes location of ground zero, total yield of burst, and height of burst (either air or surface). NUDET information might be extracted at the EOC level by plotting BOS states on a map of the region and determining the overall size of the area reporting damage from prompt effects. Since the reports of prompt effects appear only as HIFIRE or LOFIRE designations, the existence of fires is the basis of measurement of the extent of damage due to prompt effects.

Location of the ground zero of a single burst should be possible by this technique to an accuracy of, perhaps, 1 to 3 miles. Location does not depend on actual distances at which effects occur but only on the symmetry with respect to direction of reported damage distances. That is, if prompt effects damage is reported at about the same distance all around the burst, it does not matter whether that distance is 2 miles or 10 miles. This factor, in turn, depends on the size and shape of the operating zones and on the likelihood of errors (as to BOS state) in the reports. The difficulties would be substantially increased by the occurrence of multiple bursts in the same metropolitan area. These problems of error, incompleteness, and sampling of data can be solved largely by the proper use of simple intelligence processing techniques at EOC and

higher levels.* With the use of such techniques, the resulting data could be of great value in assessing the unfolding pattern of an attack across the nation.

Total yield would be a more difficult parameter to assess using only BOS reports. Yield estimation would depend on the measurement of observed distance of fire damage from an estimated ground zero. Distances of these effects depend not only on yield but also on height of burst and visibility. Errors from these sources would cause substantial errors in estimated yield. Figure 3 indicates errors introduced by variations in visibility. Inability to distinguish between air and surface burst could result in an error in yield of about a factor of 3. This error could be largely eliminated 1/2 to 1 hour after burst by confirming radiation readings (or lack thereof). As a result, immediate BOS conditions would be sufficient only to distinguish bursts differing by about a factor of 10, e.g., 0.1, 1.0, 10 MT. This error probably could be reduced to about a factor of 3 by confirming air or surface burst and by use of other observational data.

BOS reports could be one of the principal means of distinguishing air and surface bursts.† However, determination would be delayed for 1/2 hour or more until fallout arrival, or lack thereof, was confirmed. The use of the BOS method might not enable distinguishing between a closely spaced group of air and surface bursts; however, this possibility would appear to be unlikely and not too important for civil defense and other users of BOS.

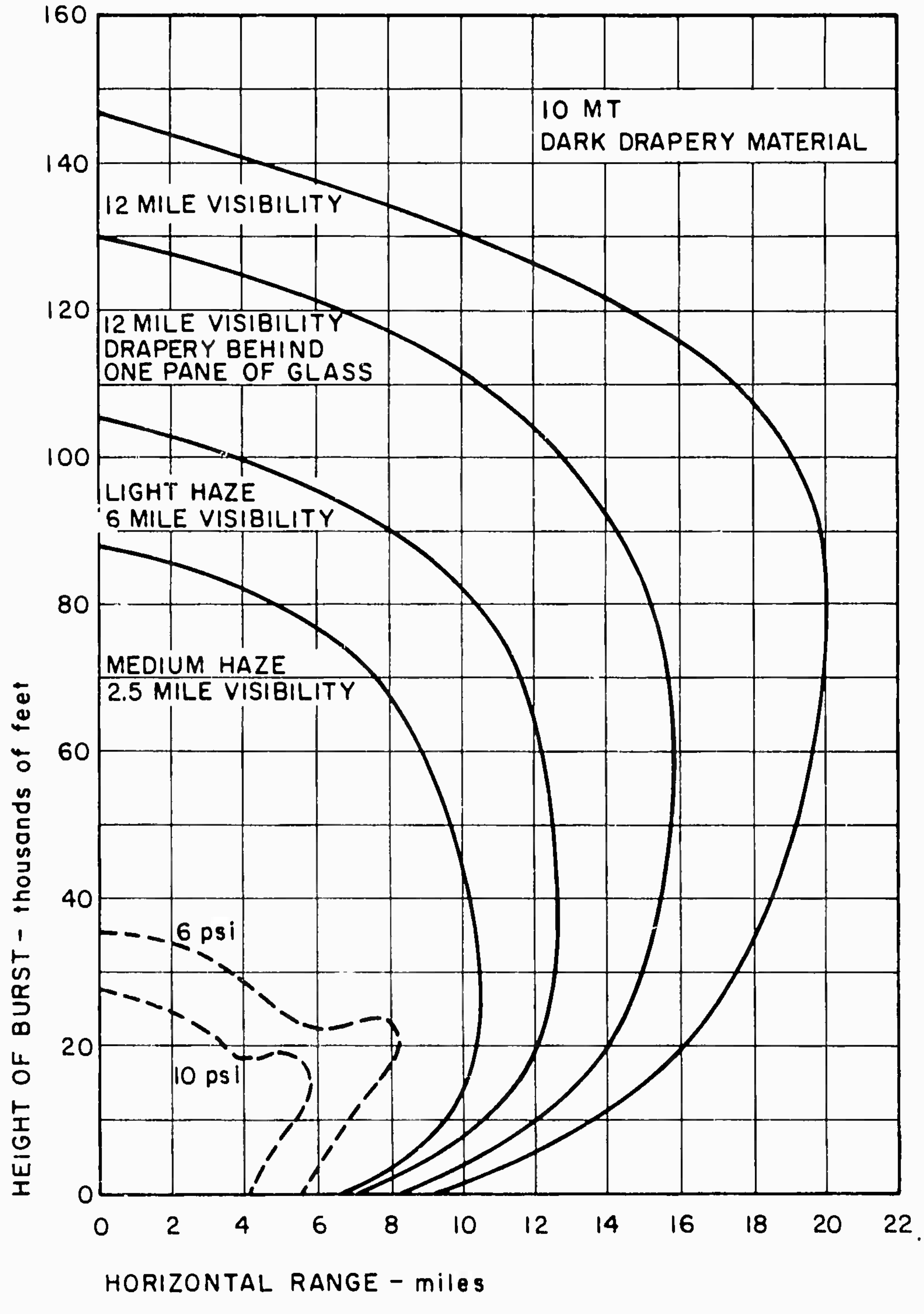
An important factor not derived directly from BOS reports would be the number of arriving warheads. Closely spaced bursts in area and time could go unobserved based on BOS reports, since changes in BOS conditions in unaffected areas would be required to identify new bursts. The simplest procedure in this event is for the EOC to make provision to count immediately the number of events observed at each operating zone and at the EOC.

---

* See R. Rodden, A Statistical Information System for Estimating the Magnitude and Scope of Nuclear Attacks, Stanford Research Institute, February 1968.

† Results of recent CDEX exercises seem to have confirmed the utility of using BOS for fallout.

FIG. 3 DRAPERY IGNITION RANGES



Ref: John, F., Protection Against Standoff Thermal Attacks, SRI, February 1967, RM 5205-58

IV SIZE OF THE OPERATING ZONES

The FCDG "Concepts" section suggests that operating zones should be relatively small in area compared with the scale of weapons effects, so that any given zone would experience few operating situations (and preferably only one). This recommendation leads to a suggested maximum size for an operating zone of about 25 square miles (with a maximum side of about 5 miles). A stylized representation of operating zone size compared with the range of effects of a 10-MT weapon is shown in Figure 4.

The size of 25 square miles would encompass most cities under 50,000 and some compact cities up to 100,000 population. Distribution of size of cities as a function of total population (1960) is given in Figure 5.

The maximum size for operating zones can be investigated by examining the likelihood of more than one BOS condition existing in an operating zone. Two conditions would occur whenever the threshold value between two BOS states was observed in an operating zone.

For fallout, the threshold values, to a degree, are arbitrary, so that more general results can be obtained by examining the dose rate gradients across operating zones and by determining the likelihood of observing dose rate gradients in excess of any given amount.

It is not possible to indicate where, in general, an operating zone would be relative to a ground zero. Consequently, there appears to be some utility in examining this problem under the assumption that operating zones are randomly located with respect to weapons effects. With respect to fallout, the assumption has been made that the operating zone is equally likely to be located in any portion of the fallout pattern. This is actually the conditional probability that if the operating zone were subjected to a fallout event at all, it would be equally likely to be in any portion of the pattern.

A convenient way to describe the variation of dose rates across an operating zone is in terms of a BIR (boundary intensity ratio). This is the ratio of the maximum standard intensity in an operating area to the minimum intensity in that area. For instance, if the maximum standard intensity were 100 and the minimum standard intensity were 10, then the BIR would be 10. The BIRs used in "Concepts" are 100 (50/0.5 r/hr).

The cumulative frequency of occurrence of BIR less than a given amount can be calculated for any yield and wind speed. Figure 6 illustrates this cumulative frequency of occurrence as a function of size of operating zone (where size is given in terms of the diameter of a

FIG. 4 CLOSE-IN EFFECTS OF 10-MT SURFACE BURST

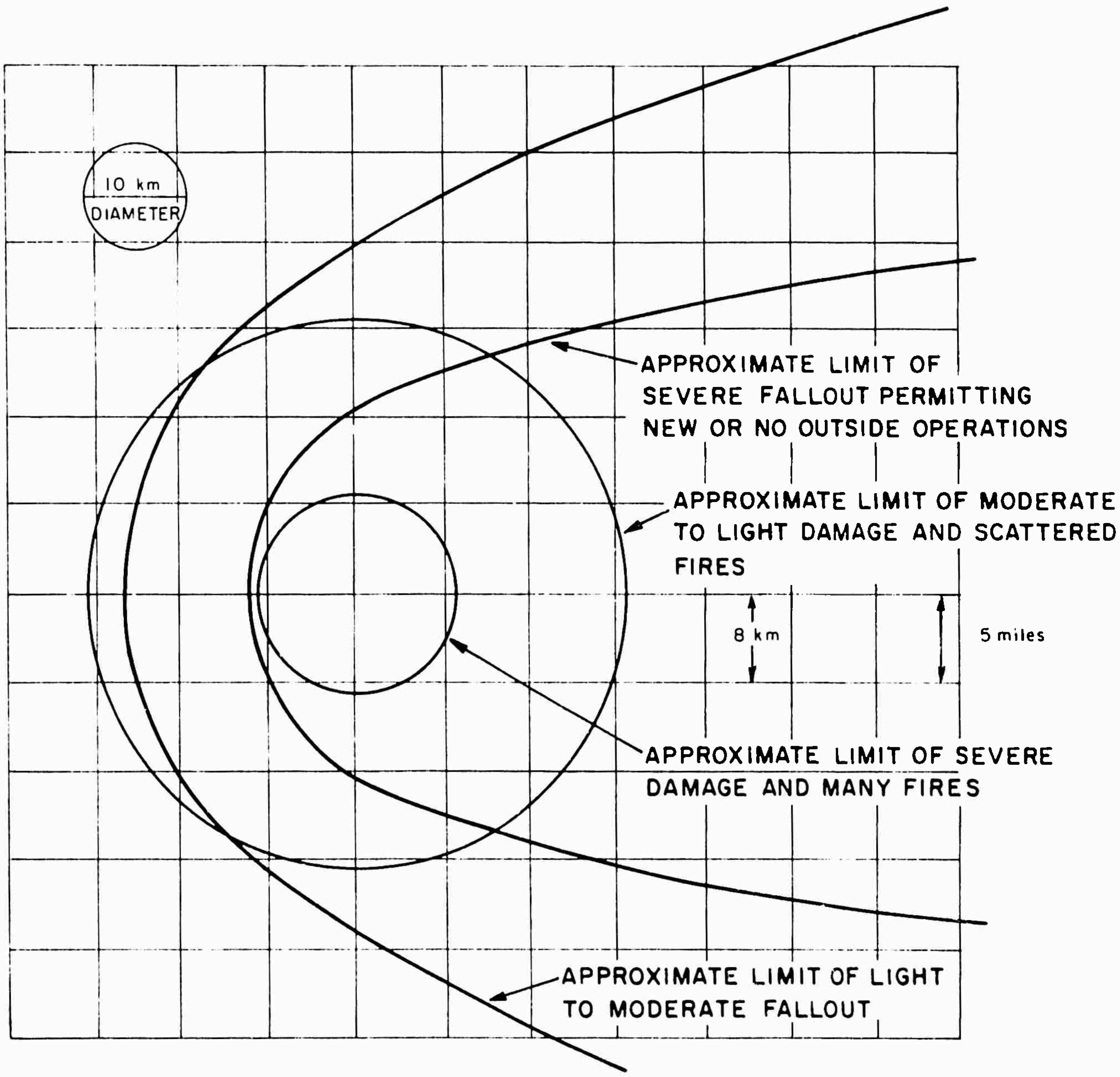


FIG. 5 POPULATION AND LAND AREA OF URBANIZED AREAS 1960

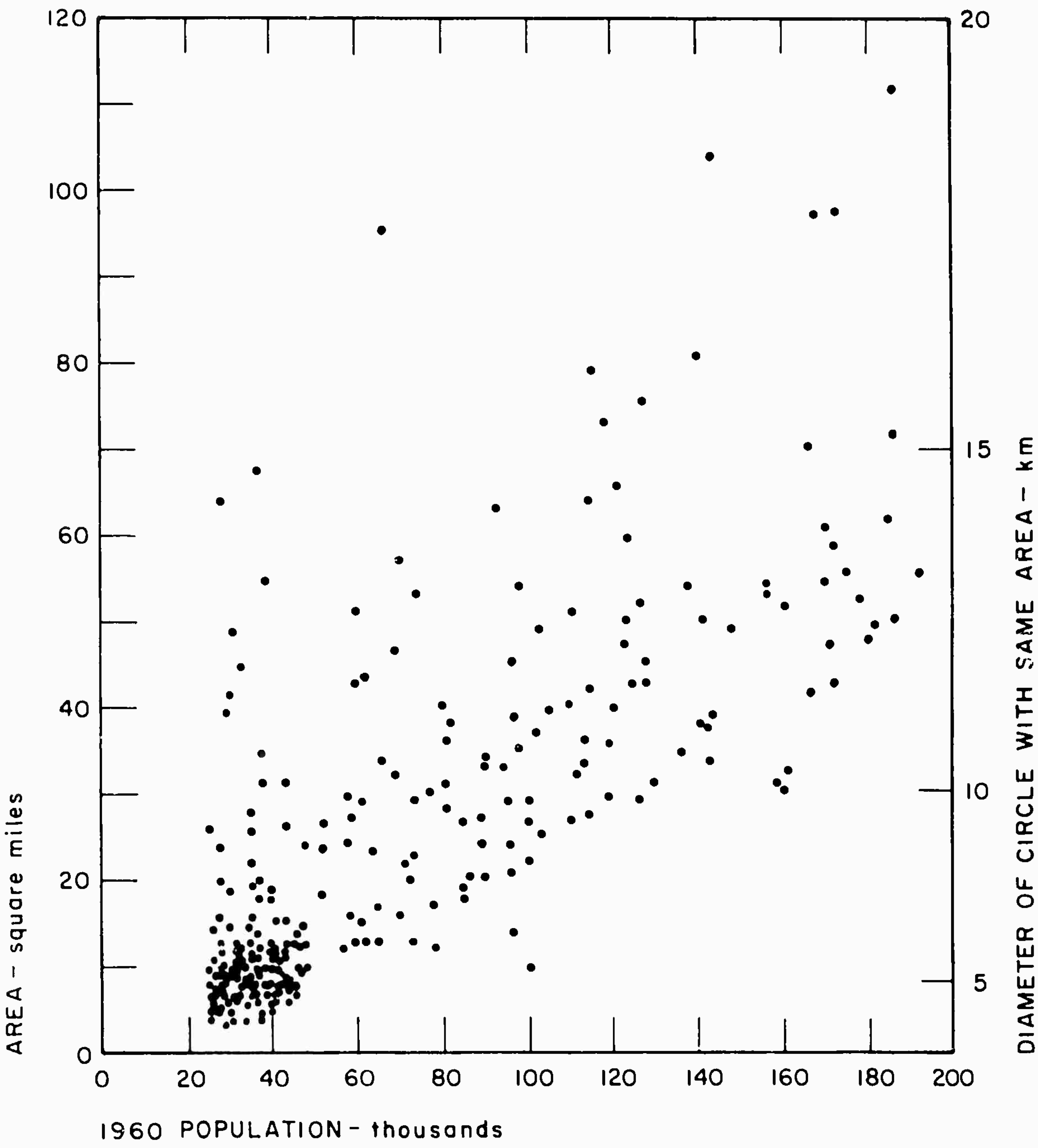
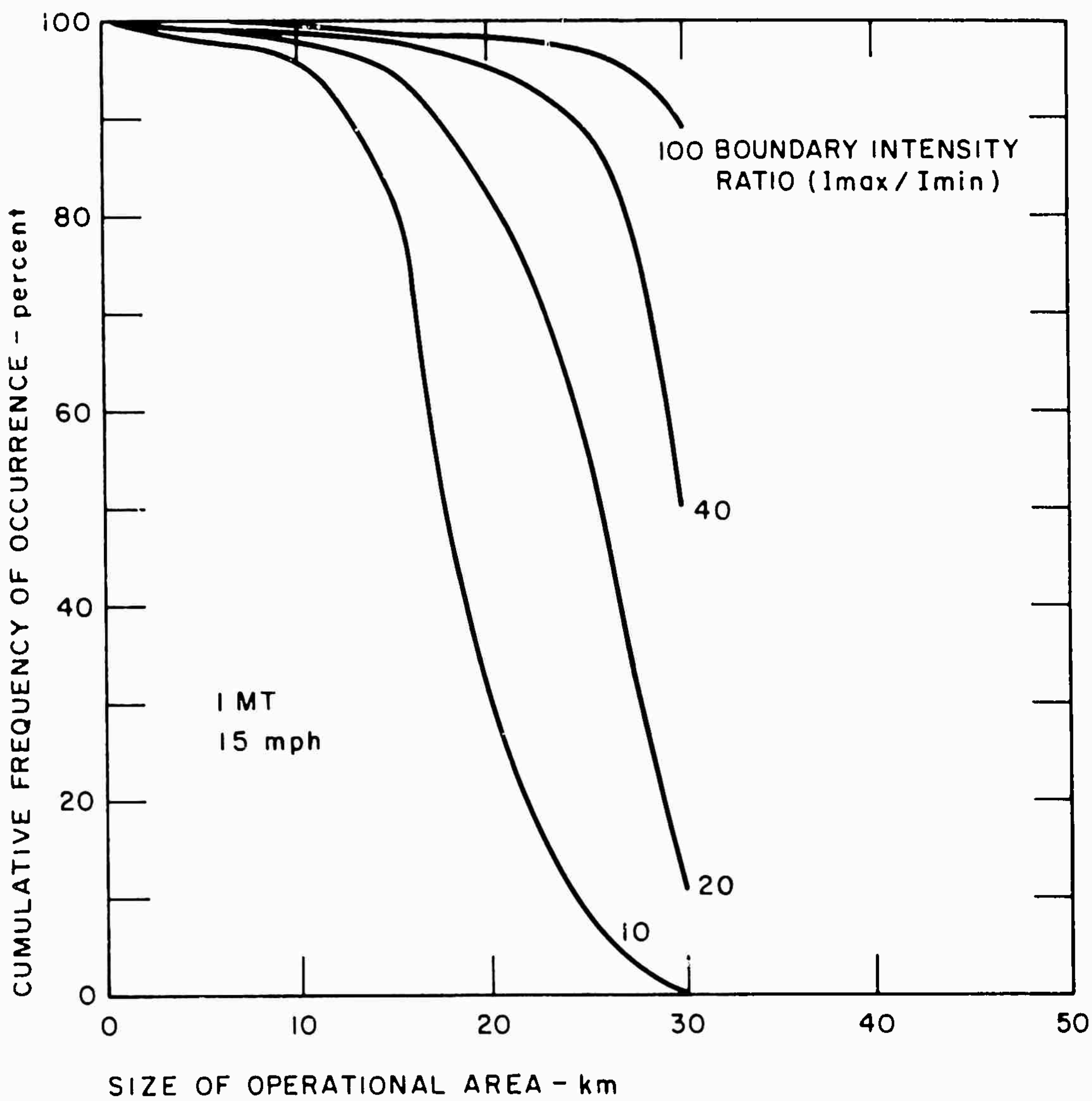


FIG. 6 PROBABILITY OF HAVING AT LEAST THE BOUNDARY INTENSITY RATIO ACROSS AN OPERATIONAL AREA OF GIVEN SIZE WHEN PLACED RANDOMLY IN A FALLOUT PATTERN



circle).* For this case (1 MT, 15 miles per hour), it will be noted that for an operating zone of 10 km or less, the cumulative frequency of occurrence of BIRs less than 10 is about 95 percent. It will also be noted that the frequency occurrence of BIRs less than 100 remains at about 90 percent for operating zones as large as 30 km in diameter. For BIRs of 40 or more, zone diameters as large as 20 km would be permissible at this 90 percent level of assurance. A level of 40 might be a more reasonable BIR to consider in this case to allow for radiation measurement errors.

These same relationships can be exhibited in a more convenient form as shown in Figure 7. The cumulative probability of occurrence is given as a function of the BIR for various sizes of operating areas. Again it will be noted that diameters of operating zones less than 20 km would be satisfactory for conditions where the threshold values differ by a factor of 40 to 100. Results are for a standard intensity range of 100 to 1,000 r/hr, but quite similar results are obtained in a range of 10 to 100 r/hr.

The Miller model, or any theoretical model, tends to eliminate irregularities found in fallout plots of actual nuclear bursts. Since the Miller model was based on the careful examination of the field test data (and especially the observed gradients), it is perhaps the most suitable for present purposes. A comparison with actual burst contours of a multimegaton weapon (Castle Bravo) is given in Figure 8. In this instance, diameters as great as 40 km for operating zones would have been acceptable.

The previous graphs illustrate the process for one yield and wind condition. In Figure 9 a similar relationship is shown for a 5-MT weapon using the climatological wind rose from the high-altitude wind observation station of Oakland, California. In this instance, operating areas with 10-km diameter would be satisfactory with BIRs of 10 or more. Areas with diameters of less than 20 km would be highly satisfactory with BIRs of 40 or more.

Figures 10 and 11 indicate the influence on acceptable area size of weapon yield for various assurance levels, i.e., assurance that the BIR will not exceed 20 or 40, respectively. Results in these figures are for a 15-knot wind. For the conditions in Figures 10 and 11, a 20-km area would be highly satisfactory down to yields of about 0.5 MT. Consideration of the full wind spectrum would reduce the maximum acceptable size area by a factor of about 2; however, the 10-km diameter area still should be acceptable.

---

* Miller fallout model has been used in all cases except as otherwise stated. See C. F. Miller, Fallout and Radiological Countermeasures, Stanford Research Institute, January 1963.

FIG. 7 PROBABILITY OF HAVING NO MORE THAN THE BOUNDARY INTENSITY RATIO INDICATED ACROSS AN OPERATIONAL AREA OF GIVEN SIZE WHEN PLACED RANDOMLY IN A FALLOUT PATTERN – 1 MT, 15 MPH WIND

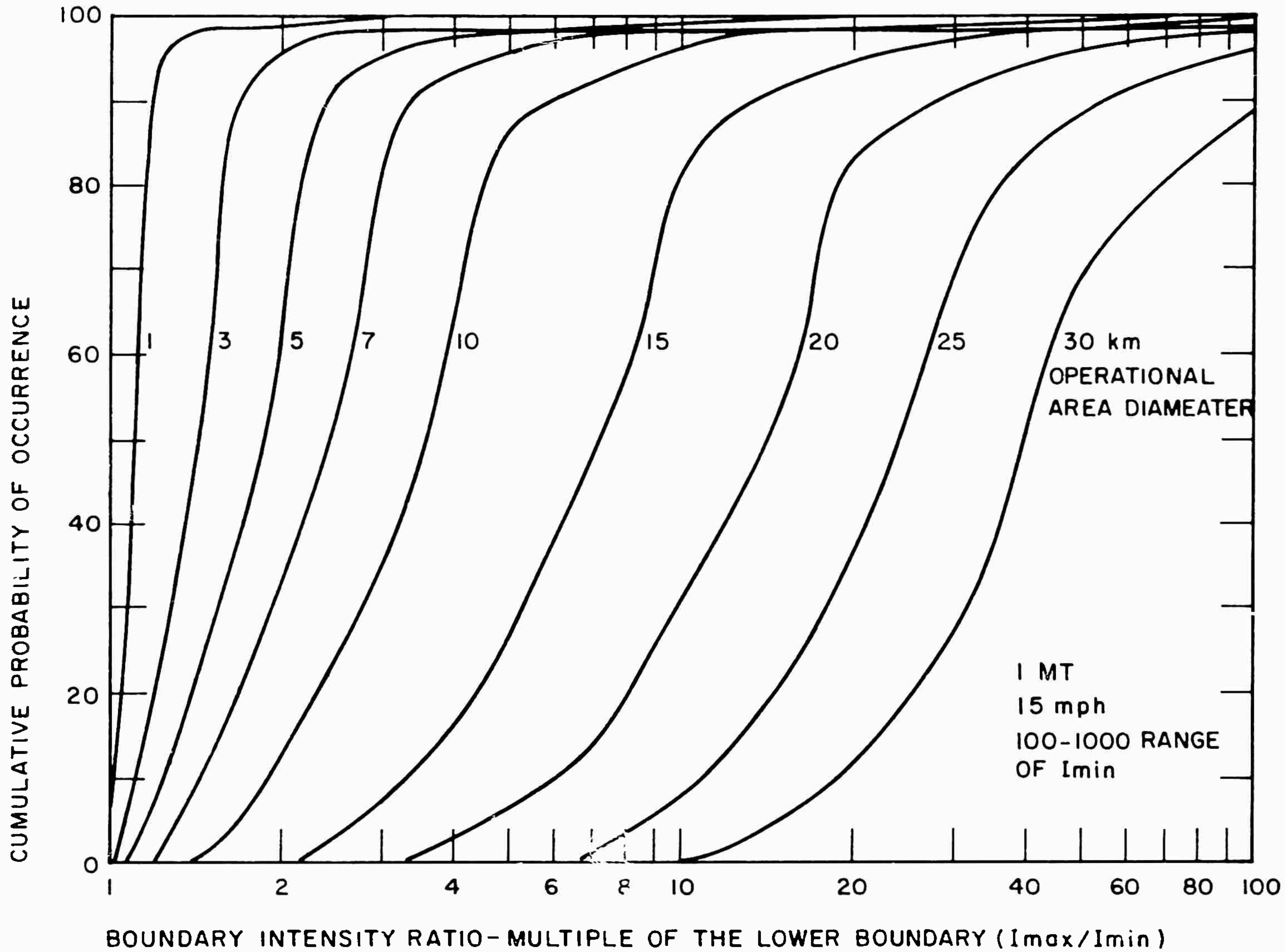


FIG. 8 PROBABILITY OF HAVING NO MORE THAN THE BOUNDARY INTENSITY RATIO INDICATED ACROSS AN OPERATIONAL AREA OF GIVEN SIZE WHEN PLACED RANDOMLY IN A FALLOUT PATTERN – FIELD TEST PATTERN

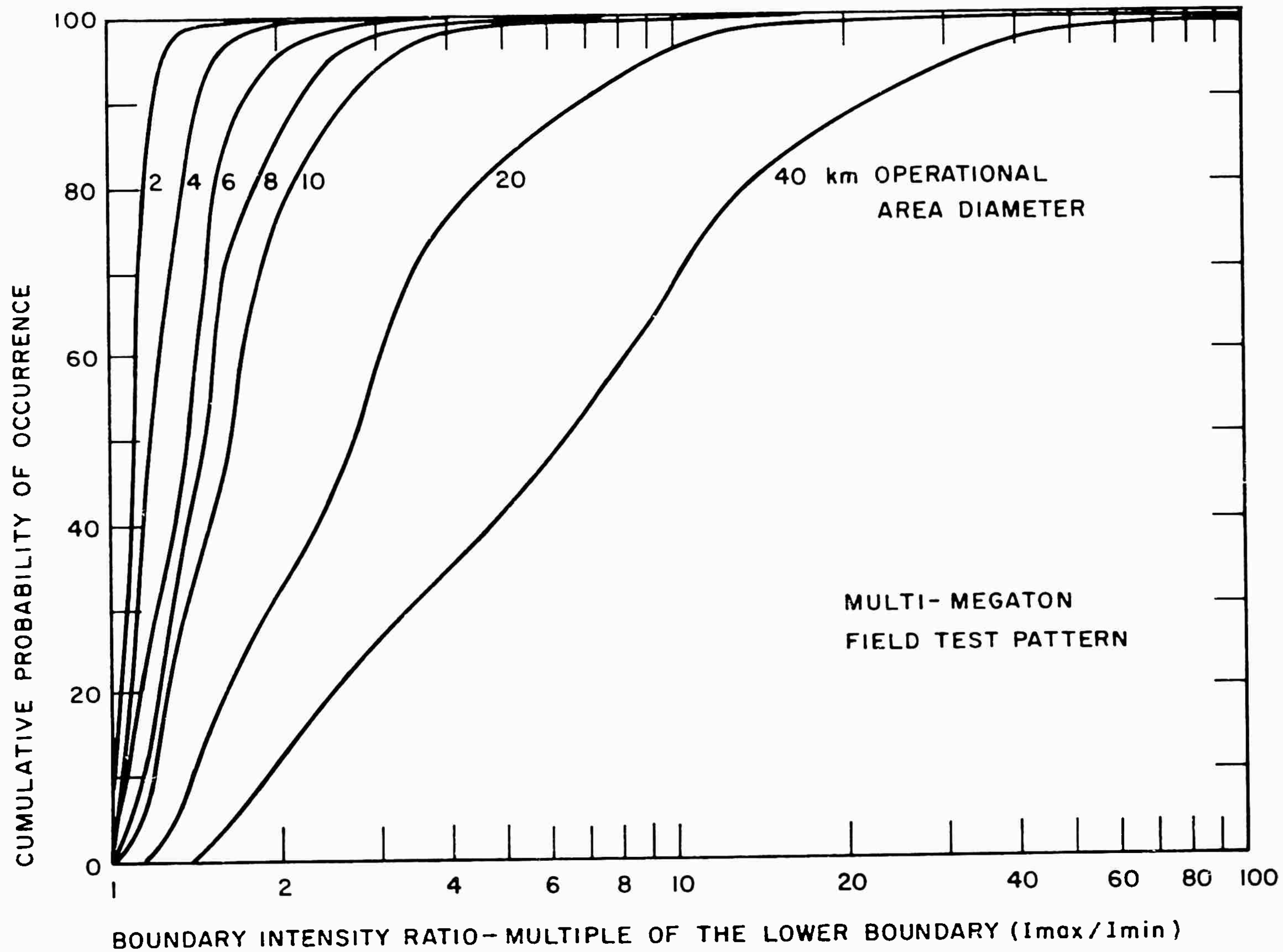


FIG. 9 PROBABILITY OF HAVING NO MORE THAN THE BOUNDARY INTENSITY RATIO INDICATED ACROSS AN OPERATIONAL AREA OF GIVEN SIZE WHEN PLACED RANDOMLY IN A FALLOUT PATTERN - 5 MT, ANNUAL WIND DISTRIBUTION

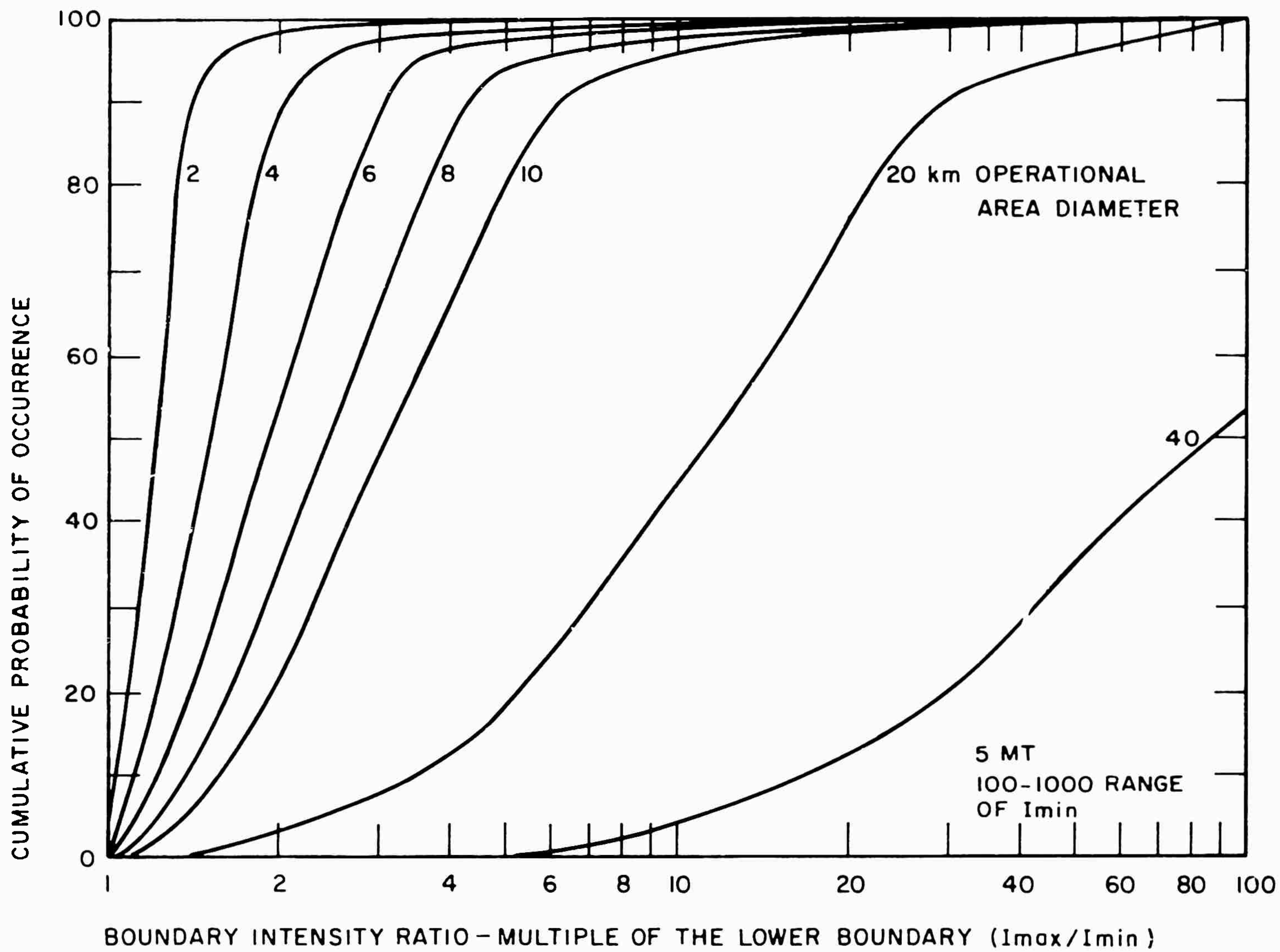


FIG. 10 SIZE OF OPERATIONAL AREA VERSUS WEAPON YIELD FOR A GIVEN PROBABILITY THAT THE BOUNDARY INTENSITY RATIO WILL BE LESS THAN A PRESCRIBED AMOUNT – $\frac{IMAX}{IMIN} \leqslant 20$

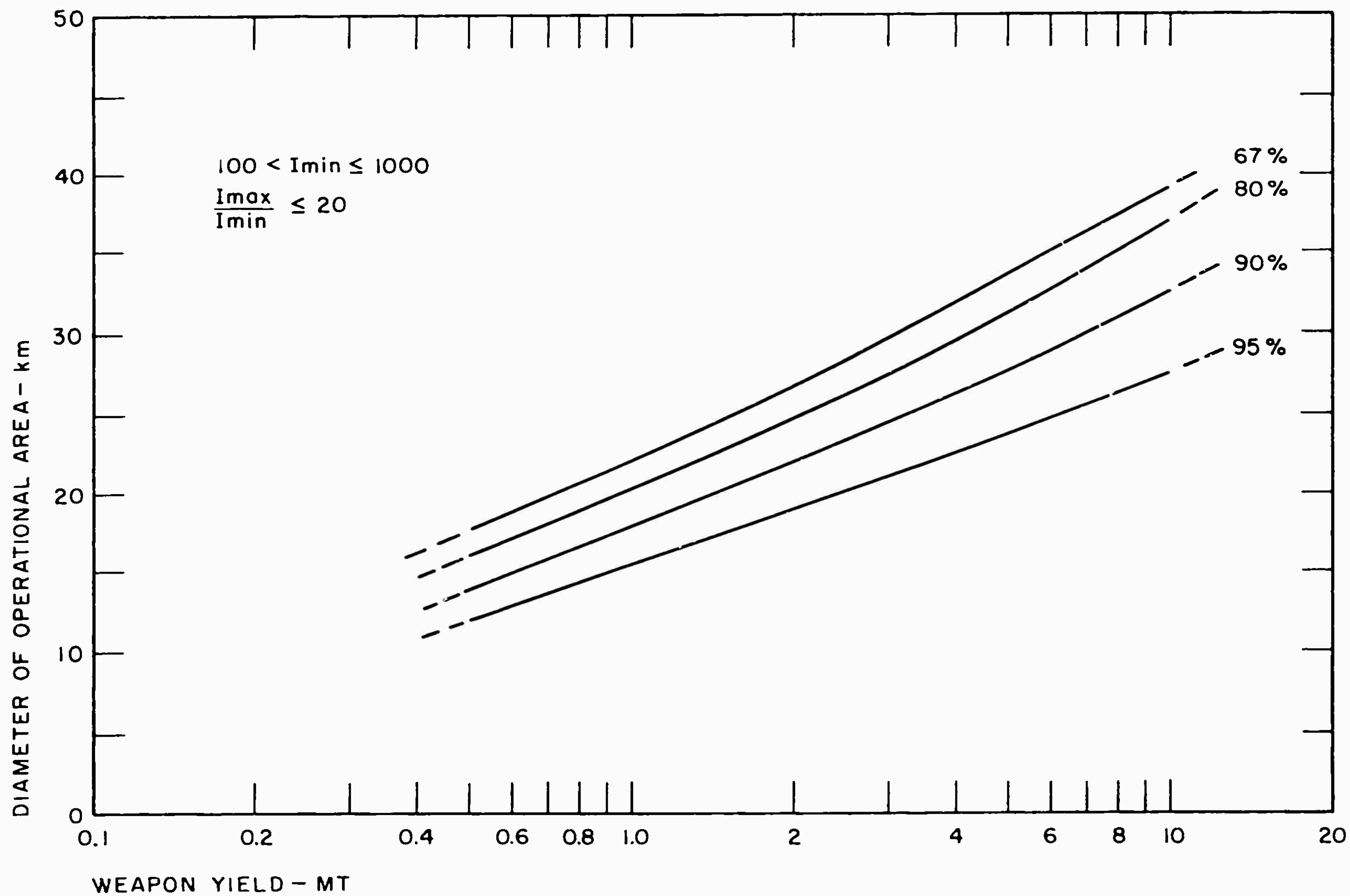


FIG. 11 SIZE OF OPERATIONAL AREA VERSUS WEAPON YIELD FOR A GIVEN PROBABILITY THAT THE BOUNDARY INTENSITY RATIO WILL BE LESS THAN A PRESCRIBED AMOUNT – $\frac{I_{MAX}}{I_{MIN}} \leqslant 40$

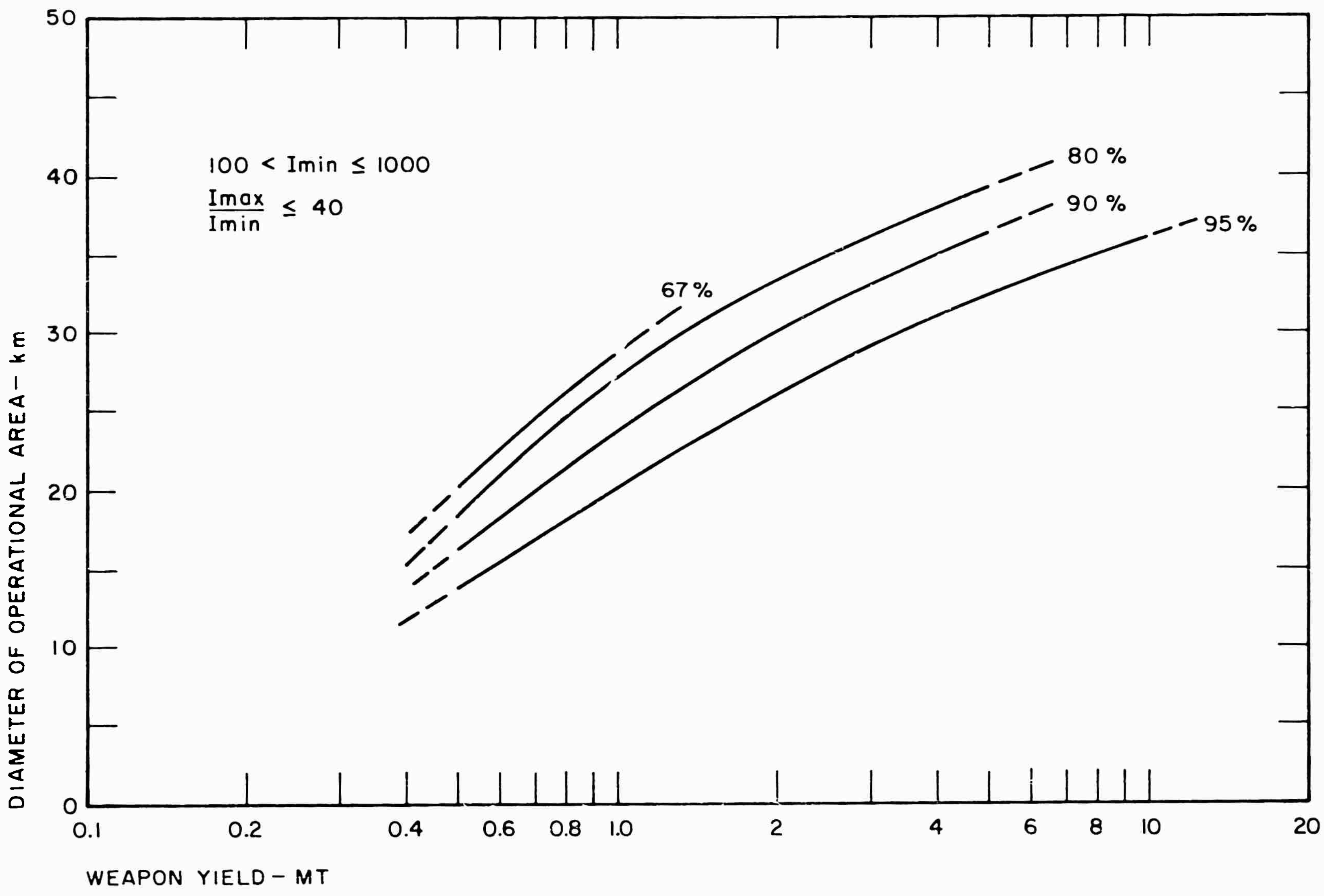


Figure 12 compares acceptable diameters for a 5-MT burst and either 15-knot winds or the wind frequency distribution for San Jose. At the high confidence level (at 95 percent assurance level), the acceptable size zone is reduced substantially from the 15-mph wind condition; however, for BIRs of 40 or more, zone diameters of 20 km are still highly satisfactory. For a 1-MT burst under similar conditions, a 10-km diameter would be acceptable.

In summary, it would appear that the wide range of dose rates allowable within a given BOS condition would be sufficient to allow operating areas in the range of 10 to 20 km in diameter, even allowing for likely measurement errors.

The scale of effects for blast damage is more concentrated than for fallout. Consequently, more limitations are placed on the size of operating areas to minimize the range of observed effects. The range of blast conditions that might be acceptable in a single BOS condition might be from 1 to 3 psi or, possibly, from 1 to 5 psi. Important civil defense operations might also be possible in the range of overpressures from 3 to 10 psi.

The maximum permissible size of operating zones that lie completely within the various overpressure ranges is given in Figure 13 for various weapon yields. If the radius of the zone is less than the range between upper and lower threshold values, then not more than two conditions would appear in the same operating zone and, possibly, only one. In the fractional megaton region, the distances between overpressures shown in Figure 13 (1 to 10 psi, 1 to 5 psi, 1 to 3 psi, and 3 to 10 psi) are smaller than the suggested maximum diameter for operating zones. For these yields, the whole spectrum of damage effects could be observed in one operating zone. For multimegaton yields, the distances between indicated overpressures generally is greater than the recommended maximum zone dimensions, so that no more than two blast conditions would be observed in the given zone. The chances of fairly uniform blast overpressures over a 25-mile zone would not appear to be high (at least in the range 1 to 10 psi).

The 1 to 3 psi region is perhaps the most significant range, since this is the range of overpressures that one would expect to be associated with a LOFIRE condition. Above 3 psi, the area would exhibit heavy blast damage, debris, and such activity associated with the HIFIRE condition. An operating zone controller observing conditions that looked like LOFIRE (1 to 5 psi) could actually have within his zone boundaries a HIFIRE condition (and for smaller yields even a NEGFIRE region). In this particular case, the LOFIRE contingency would probably be appropriate, since at least a portion of the zone might be held. However, it seems clear that the operating zone controller would find it necessary to receive reports from various parts of the zone when a blast environment existed. The EOC might also be able to assist the operating zone controller to ascertain the range of conditions by passing down reports from contiguous zones.

FIG. 12 WIND SPEED EFFECT ON OPERATIONAL ZONE SIZE

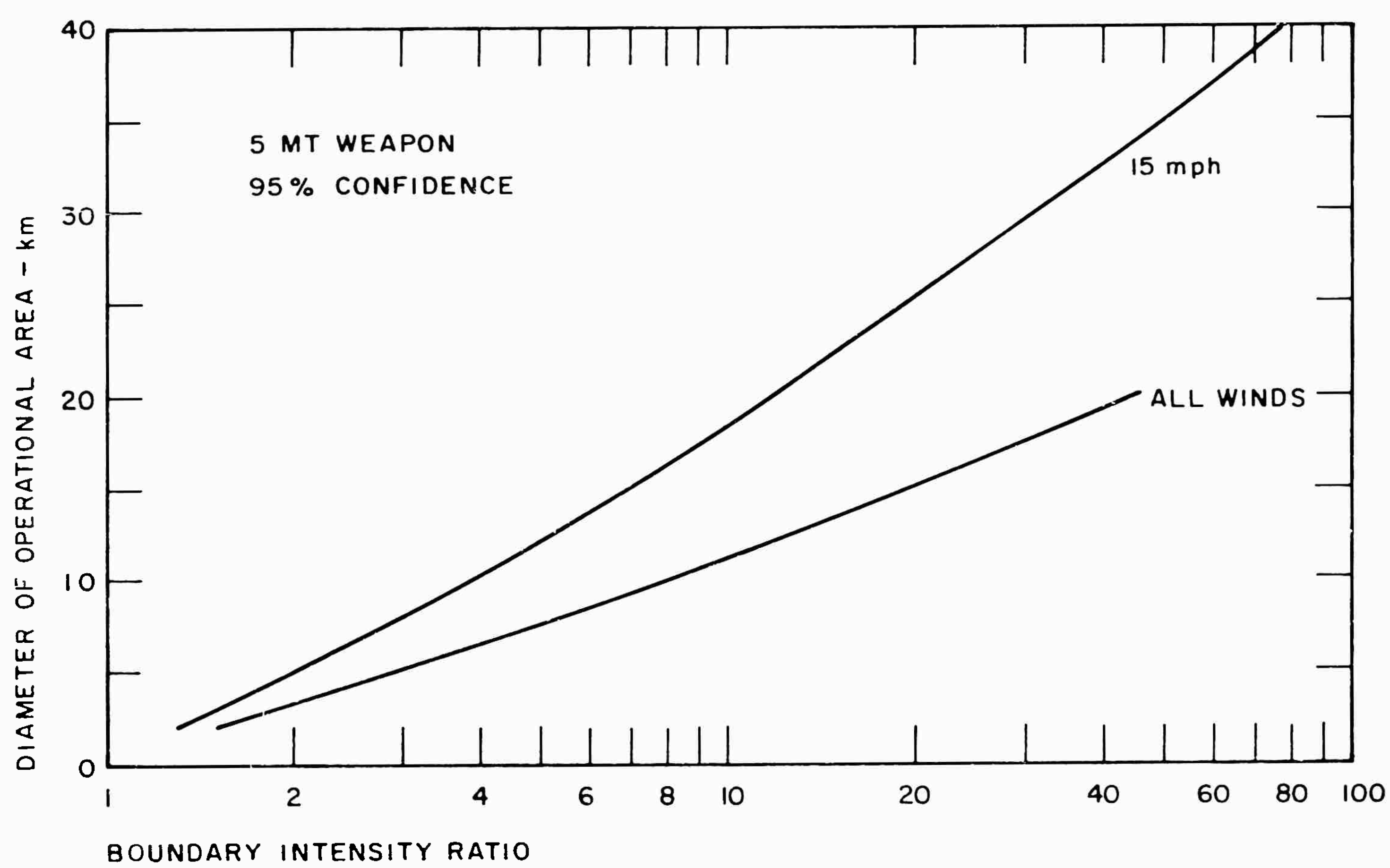
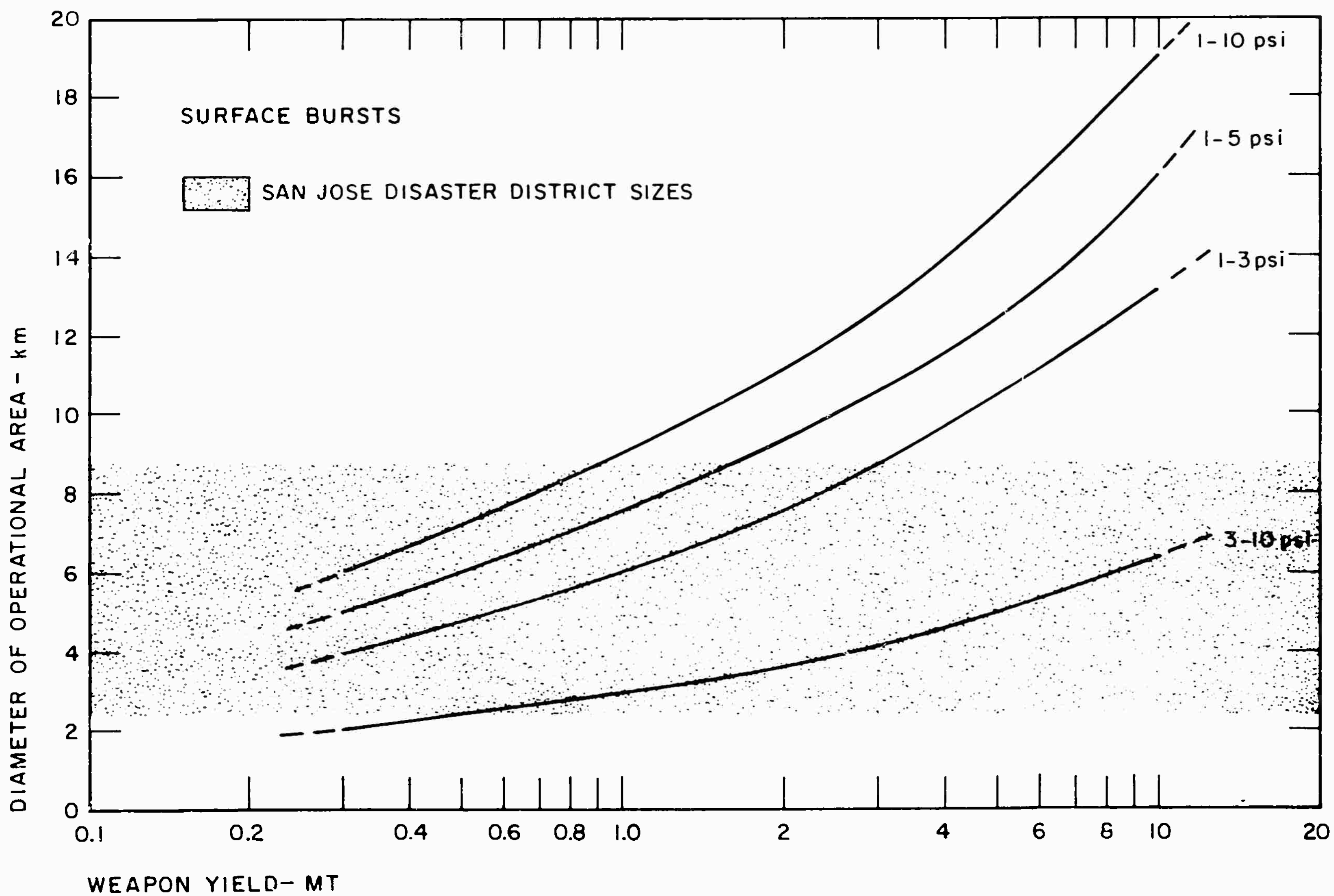


FIG. 13 OPERATIONAL SIZE AND WEAPON YIELD FOR VARIOUS PRESSURE RANGES



The fact that a wide spectrum of blast damage could exist across a single operating zone raises a more fundamental question with regard to whether one contingency plan could in fact be appropriate for an entire zone. The answer is probably that the doctrine and updated contingency plans can only outline what is to be done. The actual execution of actions still depends on the knowledge and training of civil defense personnel and population on the scene. Those writing contingency plans should not envision that they will be rigidly implemented. Rather, the contingency plans provide for a prompt initial response in the face of great uncertainty--a response that should be continuously modified as more information becomes available.

V RELATIONSHIP OF CIVIL DEFENSE COMMAND TO BALLISTIC MISSILE DEFENSE

The success of civil defense operations as currently planned would be determined principally by what happens at the local level in the first hours or days. The role of higher command during this period would be limited to providing background strategic information to help local groups make decisions. Since the current study is concerned with the 1970 time period, it is desirable to consider future trends that might influence command relationships. Requirements for closer association of military and civil organizations at both the local and national levels could increase with the introduction of BMD (Ballistic Missile Defense). The possibilities of mutual support of civil defense and BMD have just begun to be explored in any detail. However, it is already clear that active and passive defense could provide considerable mutual support. Initial explorations have already indicated that the presence of BMD would make thermal smoke screens for protection of civilian areas a more feasible undertaking.* Also, the presence of fallout shelters and emergency procedures for achieving high occupancy of these shelters would reduce the attractiveness of defense avoidance fallout attacks to the attacker.

Other possibilities for mutual support of active and passive defense remain to be explored. It appears desirable to consider the possibilities of coordinating active and passive defense tactics. For instance, it might be possible to coordinate BMD intercept tactics with alternative population distributions brought about by civil defense actions. In the event that preferential defense options are incorporated into area defense capabilities, it might be desirable for national command to play a greater role in determining the choice of local civil defense tactics.

Civil defense concepts as they currently are evolving appear to be sufficiently flexible to allow incorporation of future changes. However, these concepts alone will not make the command system successful. Unless postattack capabilities of civil defense are more thoroughly implemented, the usefulness of command action will be limited, since the operational units will have few feasible alternatives.

---

* See F. John, Protection Against Standoff Thermal Attacks, RM-5205-58, Stanford Research Institute, February 1967.

Appendix A

ADDITIONAL GRAPHS ON OPERATIONAL AREA SIZE

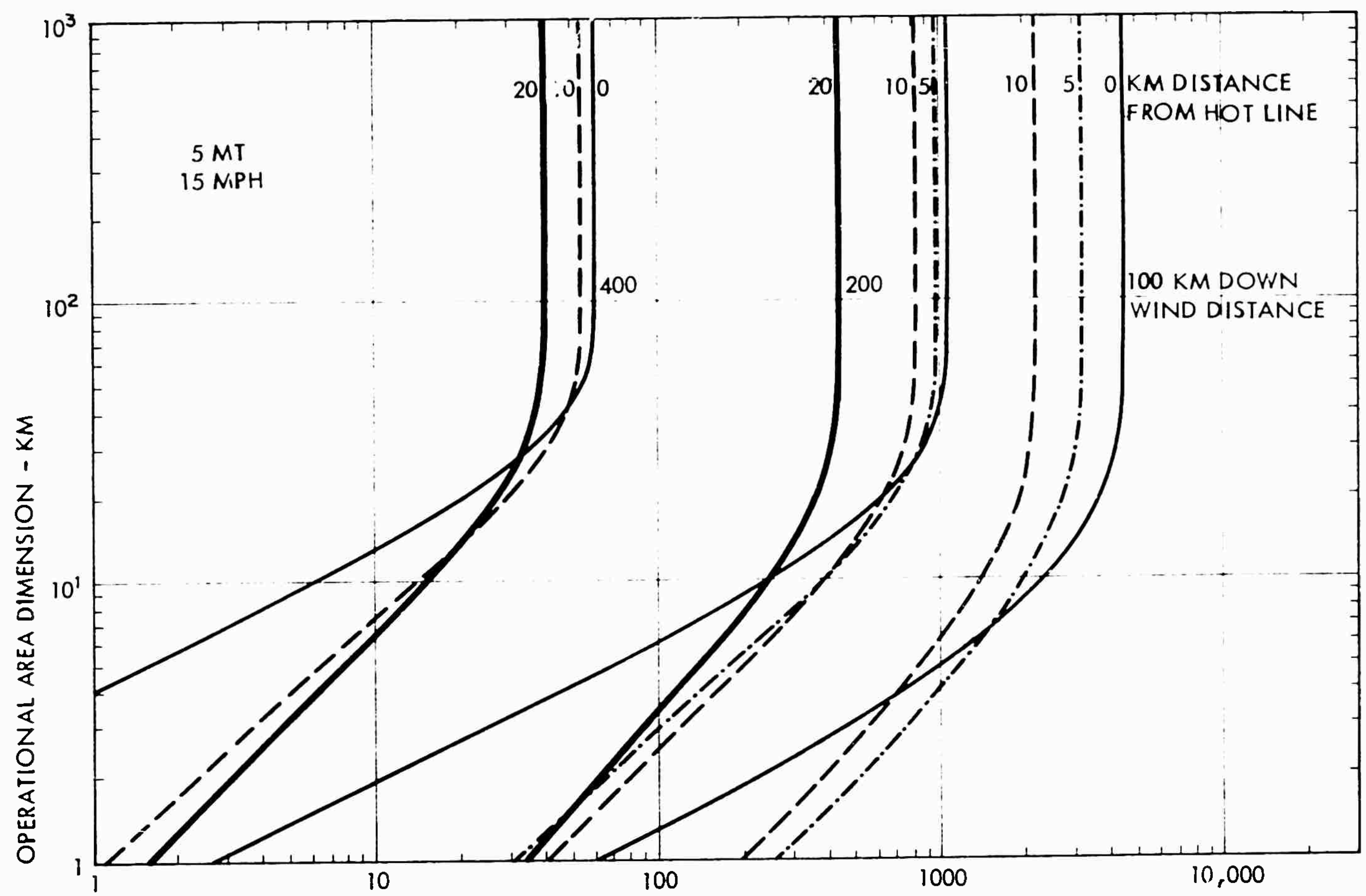
The Appendix A graphs are provided so that the variation in fallout intensity across an operational zone may be estimated for a full range of fallout conditions. These graphs are meant to complement the graphs presented in the main body of the report.

Figure A-1 gives the change of fallout intensity for various sizes of operational areas placed at a given location within a fallout field for a 5-MT weapon with a 15-mph wind. The three curves in Figure A-1 are given for locations of 100, 200, and 400 km along the hot line. The other curves in the sets give the perpendicular distances to the hot line of 0, 5, 10, and 20 km. For example, for an operational area with a 10-km diameter placed 200 kms down the hot line with its closed edges to the hot line at 5 km away, then the change of standard intensity is approximately 110 r/hr. For extremely large operational areas, one edge would be outside the fallout pattern with a standard intensity of zero. The change in the intensity then is just the highest intensity in the operational area. Thus for operational areas of 100 km or more in diameter, the change of intensity is the same as seen by the curves becoming vertical, i.e., constant change of intensity.

Figures A-2 through A-5 for weapon sizes of 0.5, 1.0, 5.0, and 10.0 MT, respectively, give the probabilities of having no more than the boundary intensity ratio indicated for various sizes of operational areas. The wind speeds were taken, using the annual wind distribution as observed at the Oakland weather station.

Figures A-6, A-7, and A-8 are similar to the preceding figure with the curves given for fixed operational area sizes and with the boundary intensity ratio as an axis. The previous curves had the reverse condition, with boundary intensity ratio held constant and the size of the operational area as an axis.

FIG. A-1 CHANGE OF FALLOUT STANDARD INTENSITY FOR VARIOUS-SIZED OPERATIONAL AREAS PLACED WITH REFERENCE TO THE HOT LINE IN THE FALLOUT PATTERN



ΔI = CHANGE OF DOSE RATE (r/hr.)

Change of Fallout Standard Intensity in an Operational Area

FIG. A-2 PROBABILITY OF HAVING NO MORE THAN THE BOUNDARY INTENSITY RATIO INDICATED ACROSS AN OPERATIONAL AREA OF GIVEN SIZE WHEN PLACED RANDOMLY IN A FALLOUT PATTERN OF 0.5 MT

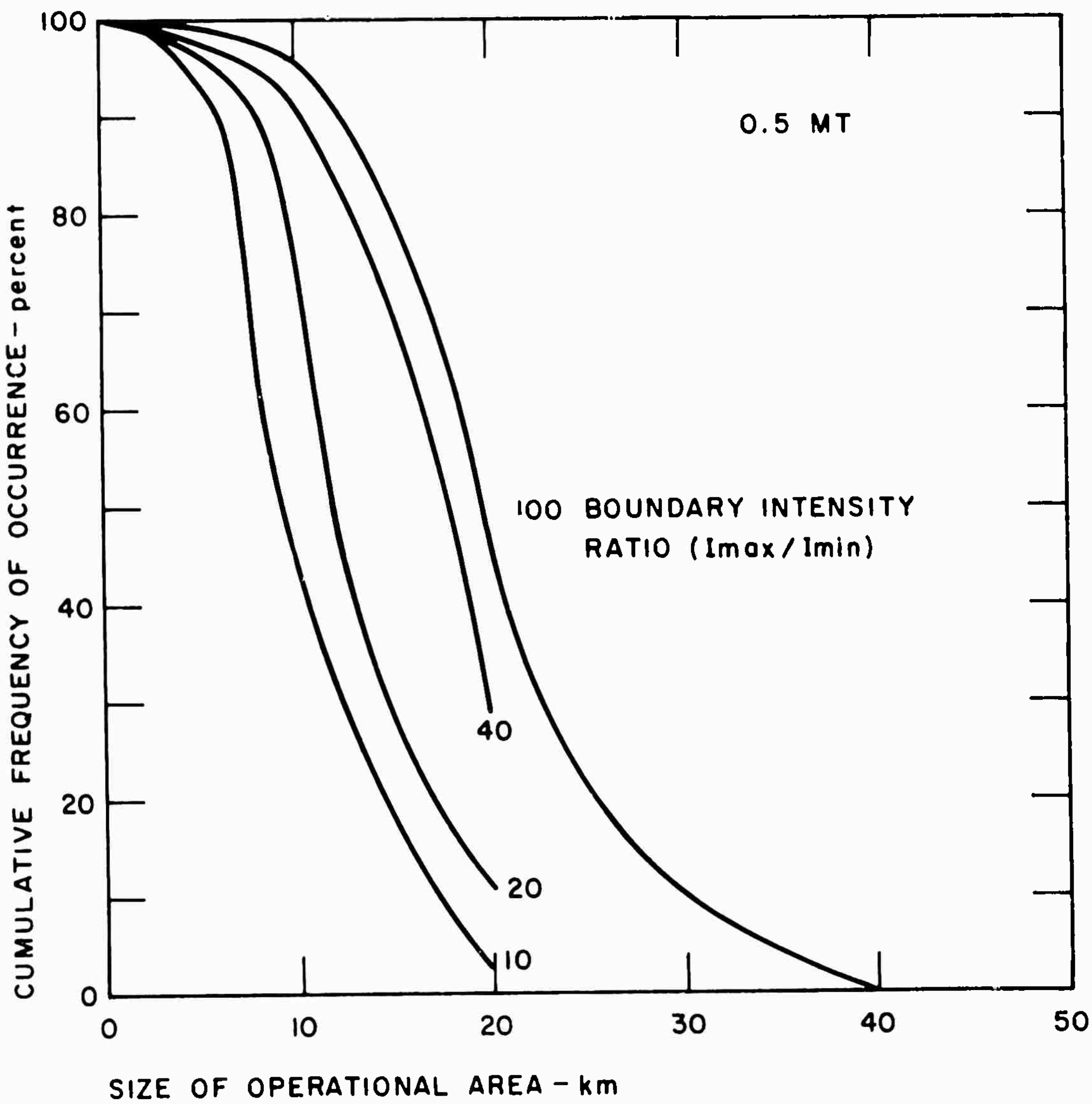


FIG. A-3 PROBABILITY OF HAVING NO MORE THAN THE BOUNDARY INTENSITY RATIO INDICATED ACROSS AN OPERATIONAL AREA OF GIVEN SIZE WHEN PLACED RANDOMLY IN A FALLOUT PATTERN OF 1 MT

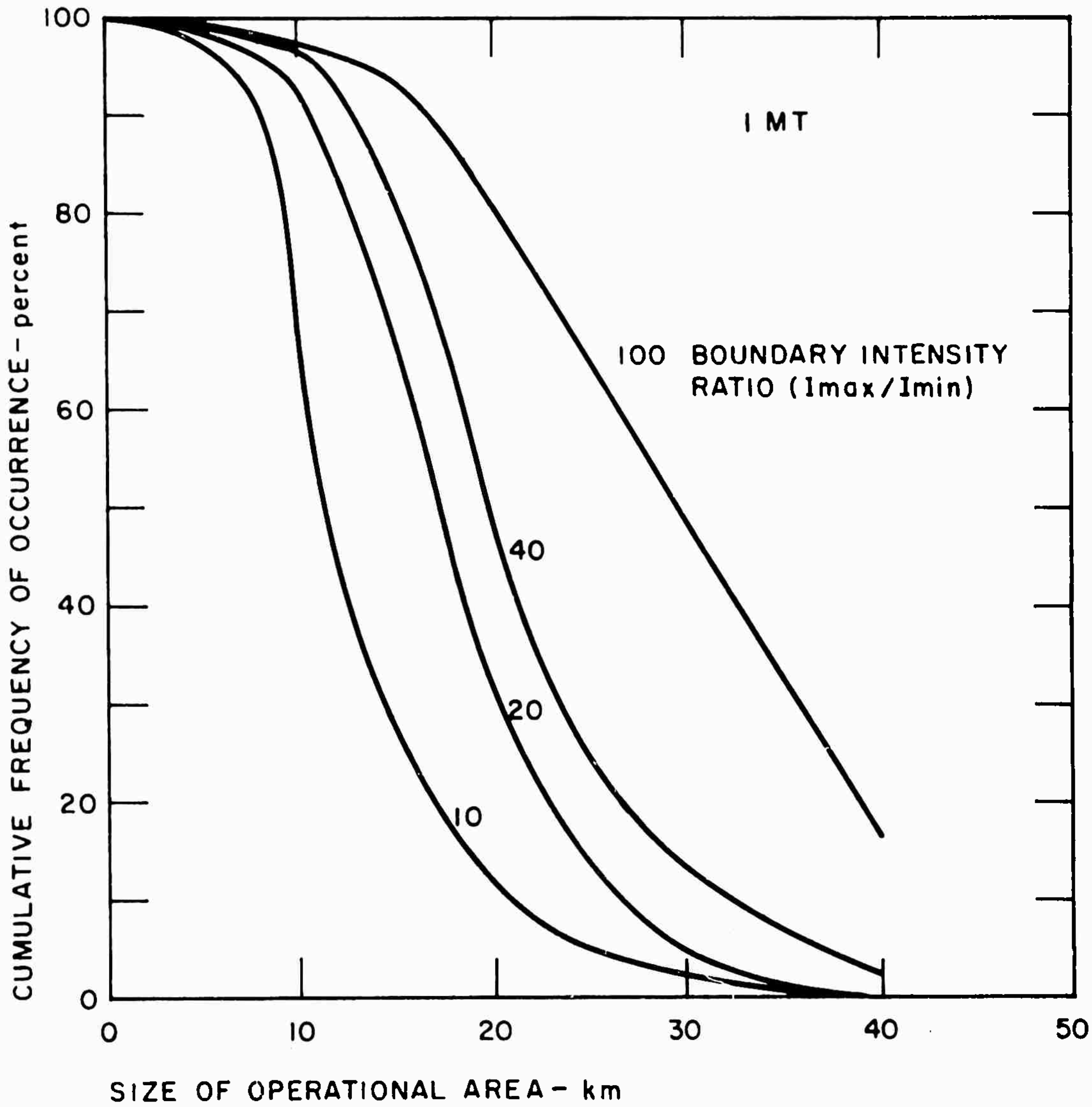


FIG. A-4 PROBABILITY OF HAVING NO MORE THAN THE BOUNDARY INTENSITY RATIO INDICATED ACROSS AN OPERATIONAL AREA OF GIVEN SIZE WHEN PLACED RANDOMLY IN A FALLOUT PATTERN OF 5 MT

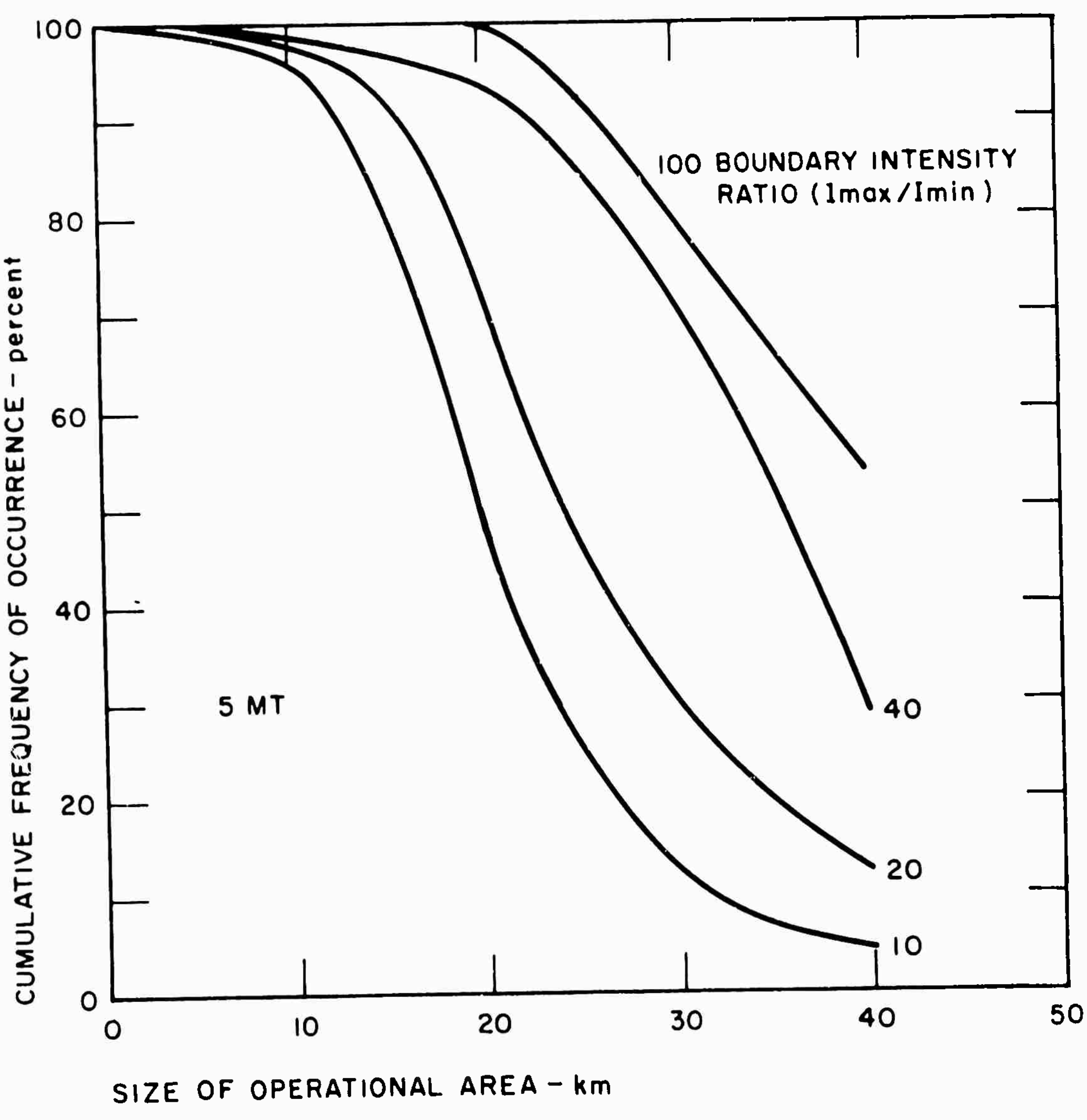


FIG. A-5 PROBABILITY OF HAVING NO MORE THAN THE BOUNDARY INTENSITY RATIO INDICATED ACROSS AN OPERATIONAL AREA OF GIVEN SIZE WHEN PLACED RANDOMLY IN A FALLOUT PATTERN OF 10 MT

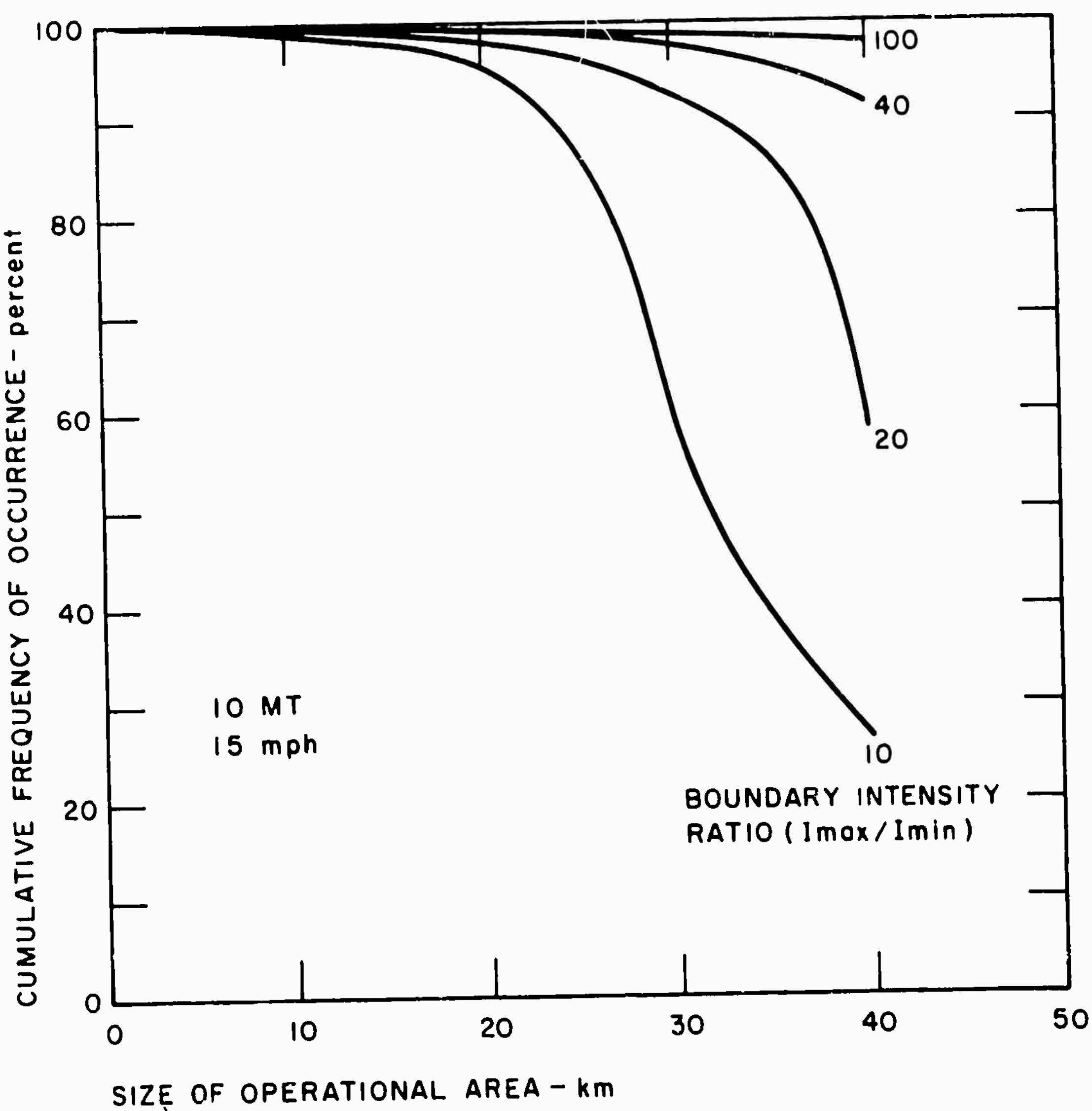


FIG. A-6 PROBABILITY OF HAVING NO MORE THAN THE BOUNDARY INTENSITY RATIO INDICATED ACROSS AN OPERATIONAL AREA OF 20 km WHEN PLACED RANDOMLY IN A FALLOUT PATTERN OF 0.5 MT

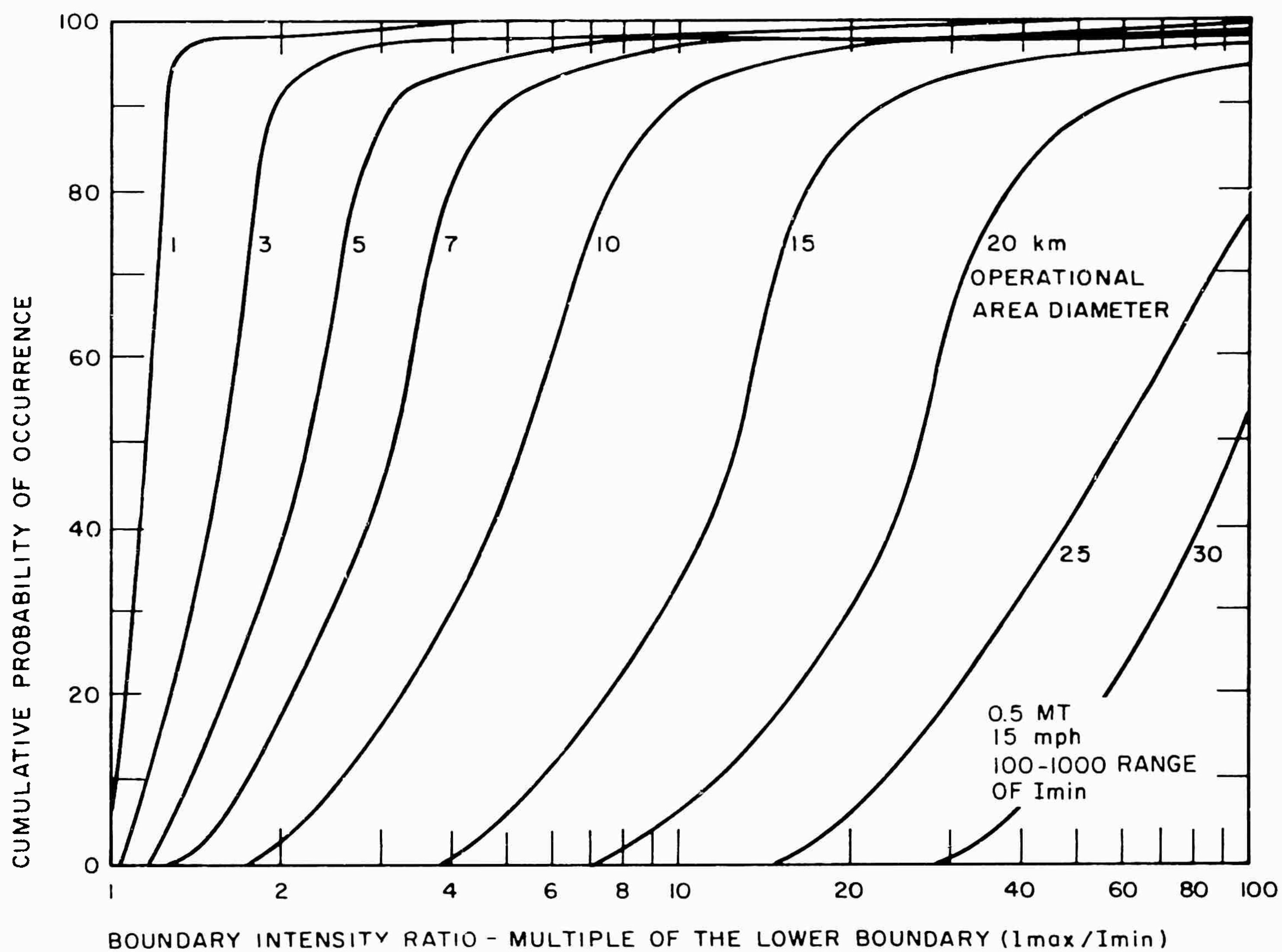


FIG. A-7 PROBABILITY OF HAVING NO MORE THAN THE BOUNDARY INTENSITY RATIO INDICATED ACROSS AN OPERATIONAL AREA OF 40 km WHEN PLACED RANDOMLY IN A FALLOUT PATTERN OF 5 MT

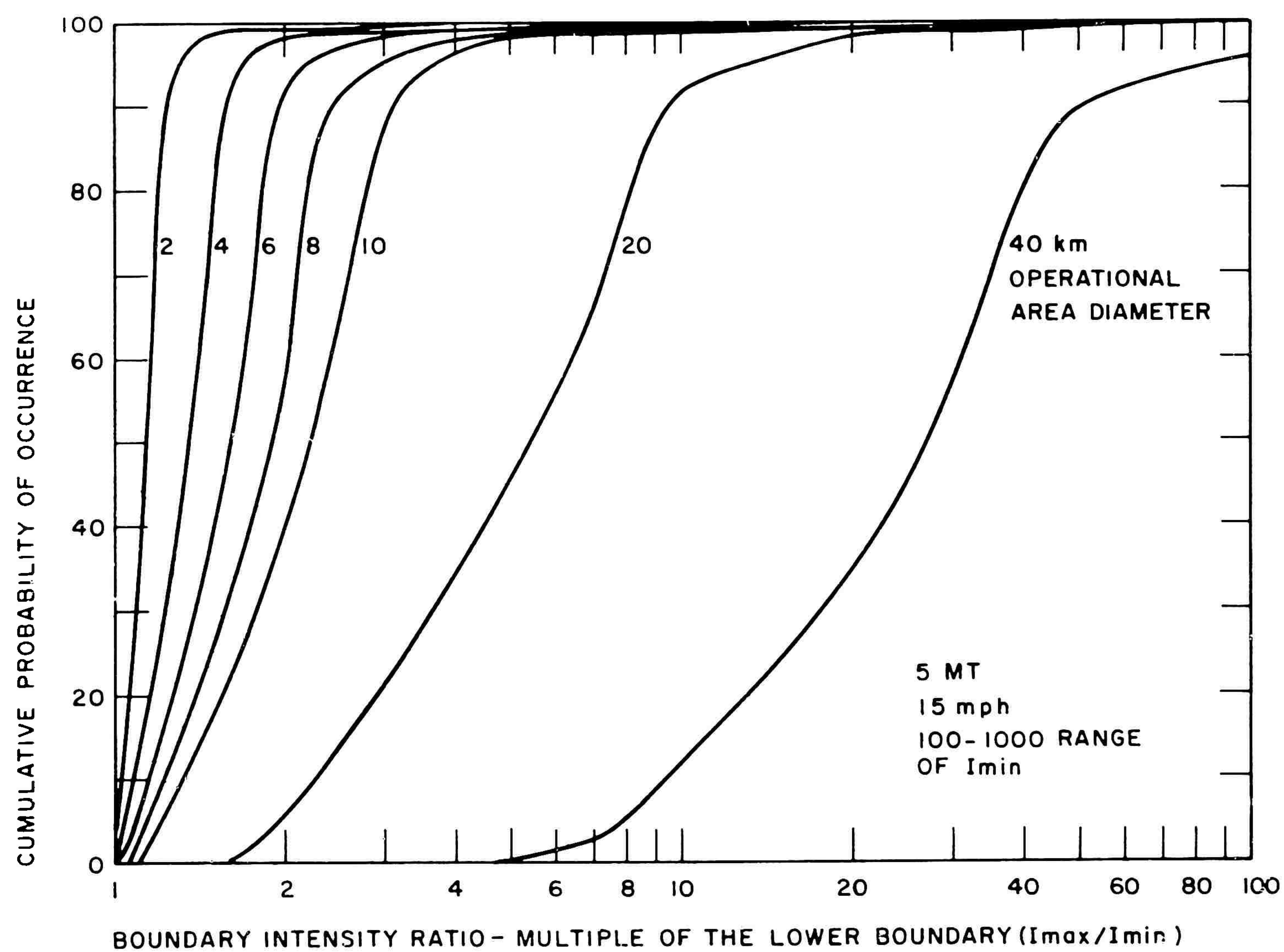
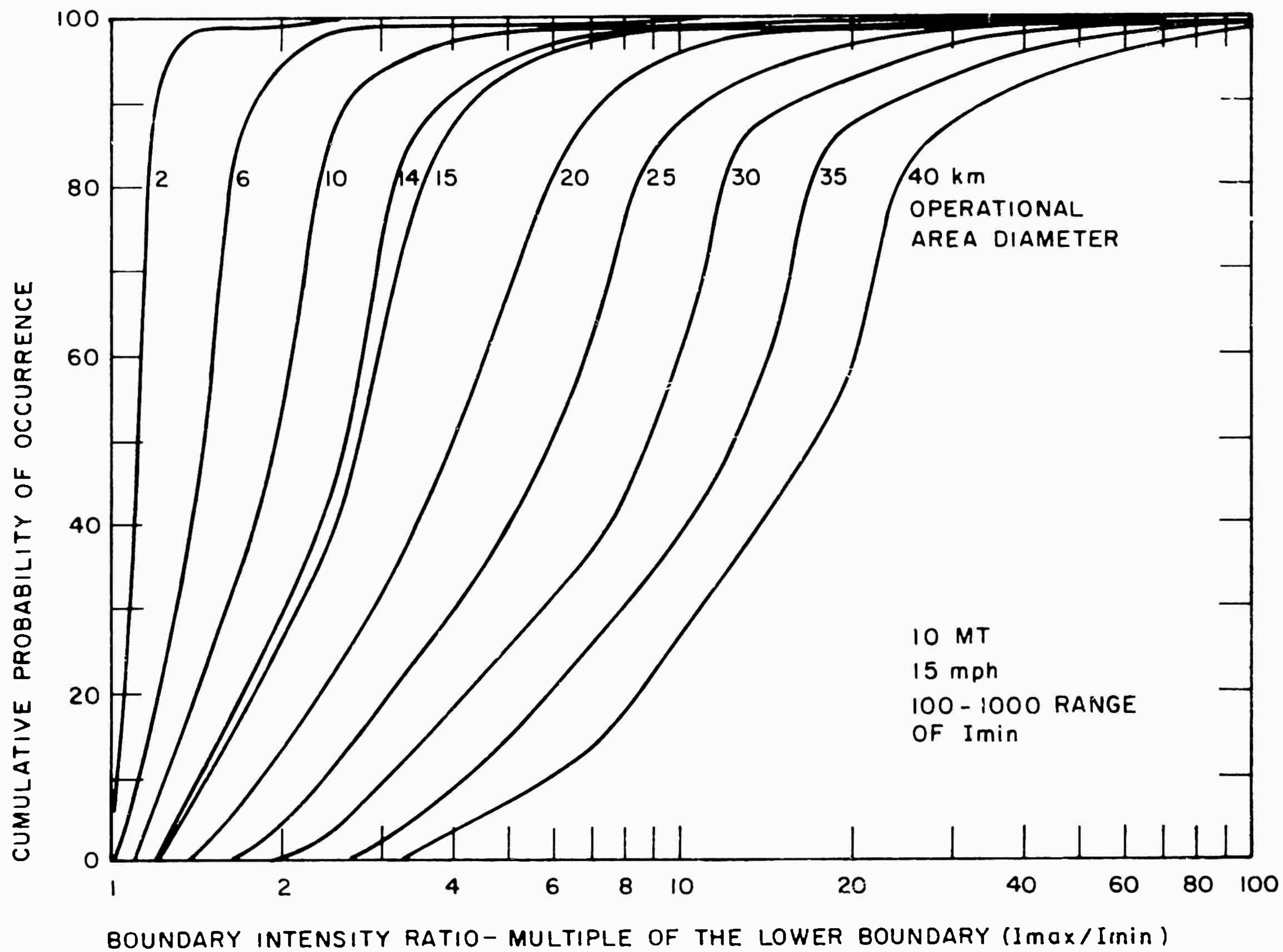


FIG. A-8 PROBABILITY OF HAVING NO MORE THAN THE BOUNDARY INTENSITY RATIO INDICATED ACROSS AN OPERATIONAL AREA OF 40 km WHEN PLACED RANDOMLY IN A FALLOUT PATTERN OF 10 MT



UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Stanford Research Institute	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

Evaluation of Civil Defense Operational Concepts

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Final Report

5. AUTHOR(S) *(First name, middle initial, last name)*
Richard Laurino
C. Alexander Kamradt

6. REPORT DATE November 1968	7a. TOTAL NO. OF PAGES 41	7b. NO. OF REFS 5

8a. CONTRACT OR GRANT NO. DAHC-20-67-C-0116	9a. ORIGINATOR'S REPORT NUMBER(S) SRI MU 6250-020
b. PROJECT NO. OCD Work Unit 2611D	
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

10. DISTRIBUTION STATEMENT
This document has been approved for public release; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Office of Civil Defense Office of the Secretary of the Army

13. ABSTRACT

The concepts of civil defense operational planning for the transattack period on the basis of expected operational situations or contingencies are reviewed. Nine situations based on combinations of selected levels of fallout intensities and weapon-caused fires are considered, including one situation involving no weapons effects. The required emergency operations attendant to each situation are identified. The geographical area for which operational contingency plans would be developed would be such that the operational situation would be the same throughout the area. Accordingly, statistical measures were developed as the basis for selection of the unit areas which show the fallout intensity gradients as a function of a range of weapon yields and probable wind conditions, expected thermal ignition ranges, and overpressure scaling functions.

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Basic operating situations Contingency planning Fallout patterns Thermal ignition ranges Probability of fallout Fire Operational zones Countermeasures						